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JAN 89 E SCHILLER
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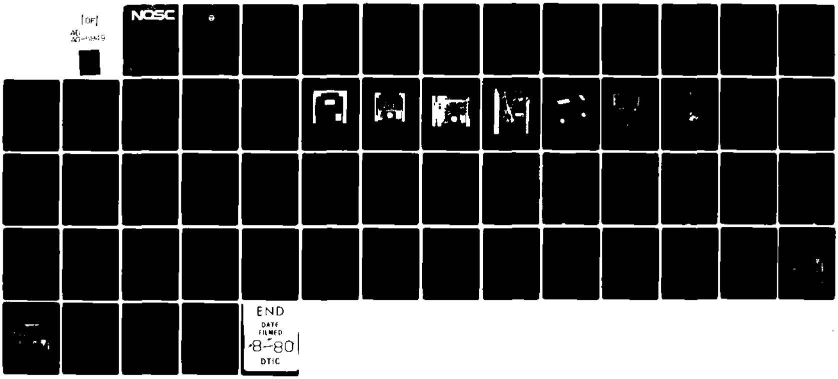

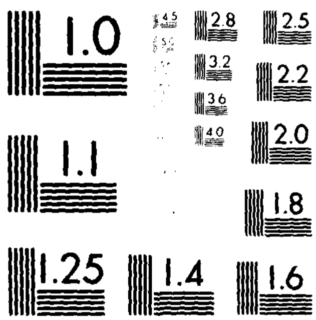

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AUTOMATIC LOUDSPEAKER CONTROL (ALC)

A summary of development and design

E Schiller

1 January 1980

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Prepared for
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This report summarizes the development and design of the automatic loudspeaker control (ALC). ~~The ALC~~ senses ambient noise levels in a given space and automatically adjusts the loudspeaker output serving that space. This eliminates hazardous loudspeaker outputs in confined spaces and, more importantly, assures unimpaired reception of vital information. In addition to covering the design approach, system description, and planned system deployment, this report also provides a listing of ALC documents available from NOSC and appendices of the primary technical data and evaluations for the ALC.

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SUMMARY

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INTRODUCTION

OBJECTIVE

This report summarizes the effort of NOSC to assist the Fleet in eliminating a shipboard loudspeaker hazard. The problem was identified as an inability to reliably regulate loudspeaker outputs in variable noise environments. It was found that some loudspeakers, set to high output for high noise environments, were being effectively disabled during low ambient noise periods. This eliminated the hazard to hearing, but also disabled a critical information network aboard ship. NOSC was tasked to develop a control device to solve this problem. The following report documents this effort.

SCOPE

The following questions are answered in this report.

- Why was the automatic loudspeaker control (ALC) developed?
- How were the design parameters selected and implemented?
- What are the final parameters, functions, and features?
- Where should the ALC be used?
- Who can install and maintain the ALC?

Electronic circuit details of the ALC are presented elsewhere, in two NOSC Technical Notes (ref 1, 2). However, final schematics for these circuits are provided in appendix A of this report. In addition, evaluation data is also provided in the appendices.

PURPOSE

This report provides both an overview of ALC development and a detailed summary of ALC design. It should be of interest to anyone concerned with loudspeaker systems used in variable noise environments.

DESIGN APPROACH

BACKGROUND

This project was conceived by Naval Ship Engineering Center (NAVSEC) personnel. They learned about the following incident. Some shipboard personnel were unaware of Circuit 1MC alarms which were being transmitted over loudspeakers and, therefore, did not react as required. The loudspeakers, reduced in level during low noise maintenance procedures, had not been properly readjusted before getting underway.

This situation is likely to recur because crew members try to protect themselves from being blasted by announcements/alarms from loudspeakers that are adjusted to be

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1. NOSC Technical Note TN 478 "Automated Loudspeaker Control for Shipboard Announcing Systems" by CR Allen, dtd 18 July 1978.
2. NOSC Technical Note TN 715 "Automatic Loudspeaker Control for Shipboard Announcing Systems" by CR Allen, dtd Sept 1979.

heard through the high noise levels created by operating equipment. If available, the loudspeakers' volume controls are turned down; if not available, rags are stuffed into the loudspeakers to muffle the output. Sometimes, when the ship gets underway, the loudspeakers are not readjusted to the higher output level, and so an announcement or an alarm might not be heard by personnel in the affected area. When loudspeakers cannot be turned down during low noise operations, such as when they are mounted on the overhead inside an LST tank deck, area personnel are exposed to very uncomfortable and probably hazardous announcement/alarm levels.

The increased annoyance and/or hazards to hearing from high loudspeaker output levels during low noise periods, as compared to high noise periods, are due to several factors. One factor is the startling effect due to the extreme difference in speaker level over the low ambient noise level, another is the lack of any warning associated with the announcement/alarm. A physiological factor, the acoustic reflex, attenuates high level sounds entering the ear to protect the inner ear from nerve damage, but the reflex activation time is slow compared to the announcement/alarm onset times and, therefore, gives little, if any, initial protection during low noise operations. (During continuous high noise operations the acoustic reflex is effective because it is activated by the ambient noise and so attenuates the entire announcement/alarm before the sound enters the inner ear.) A fourth factor, hearing protection (earmuffs or plugs), not worn in low noise but often worn in high noise, considerably reduces the sound level reaching the inner ear.

Naval Ocean Systems Center (NOSC) personnel were tasked by Naval Ship Engineering Center (NAVSEC) to develop an electronic device that would automatically adjust the output levels from the loudspeakers to provide a satisfactory signal-to-noise ratio at all times. NOSC personnel designed the ALC based on shipboard acoustical environment, speech characteristics, human engineering, reliability, maintainability, ease of installation, costs, manufacturing techniques, systems saf ty, technical level of maintenance personnel, and replacement part availability from the National Stock System. The project progressed through the following phases: requirement study, equipment search and analysis, functional design, design features, breadboard fabrication, specification for brassboard, brassboard fabrication, reliability demonstration, prototype construction, environmental testing, technical evaluation, operational evaluation, training analysis, and documentation for building to print.

Two models of the ALC were developed. One was developed for surface ships that have a central amplifier system with a 70.7 volt distribution line to power all the loudspeakers on the line. The other ALC was developed for submarines that have a distributed amplifier system with a 12.2 volt distribution line to input all amplifier-loudspeaker units on the line.

The design philosophy for the ALC is best explained by categorizing the ideas into system requirements, acoustics, electronics, packaging and personnel requirements. These categories overlap each other as does the technical talent in the three NOSC groups* that produced the ALC. The design philosophy is intrinsic to the ALC and must be considered whenever the ALC is to be adapted to another system or to be modified for manufacturing purposes.

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* Speech Systems and Interference Branch, Design Engineering Division, and C^2 Center Analysis, Design and Mockup Branch.

SYSTEM REQUIREMENTS

The shipboard environment places many requirements on equipment which must be added to standard operating requirements. Major ALC design requirements are listed below:

1. Acceptable signal-to-noise ratios must be maintained as noise levels and spectra change.
2. The ALC must control loudspeakers interior to the ship.
3. The ALC must not react to transients.
4. Complete announcements must be audible, with no sudden level changes or syllabic losses.
5. The ALC must be highly reliable.
6. Skill level requirements must be sufficiently low for installation and maintenance.
7. The mean-time-to-replace must be low.
8. Built-in-test-equipment must be provided.
9. Installations must be possible without loudspeaker alterations or additional junction boxes.
10. An ALC bypass must be automatically activated during power failure and maintenance.
11. MIL-STD-16400 environmental requirements must be met.

Extensive testing was performed at NOSC and aboard ships to assure compliance with the above requirements. Reliability testing, environmental testing, technical evaluation, and operational evaluation are detailed in appendices B, C, D and E, respectively.

Acoustics

The acoustic parameters considered during the ALC design phase are the characteristics of interior shipboard noises, shipboard loudspeakers, announcements/alarms transmitted by the loudspeakers, and the optimum frequency range for the ALC noise sensing microphone.

Measured noise characteristics are: levels, variation with time, position within a space, function, and location within the ship; and spectrum, its variation with function, and location within a ship. Aside from transients, such as dropping tools, most interior shipboard noise levels are stable for several minutes to several hours. Noise level variations as great as 50 dB, due to equipment being activated or deactivated and by changes in ship's speed, are possible – from dockside with most equipment deactivated, to full speed and at sea operations. The noise levels throughout a space do not vary more than several dB, except within the near field of the noise. The noise level at the bulkhead is usually 1 to 2 dB higher than in adjacent areas. The ambient noise levels in engineering spaces rarely exceed an A-weighted noise level of 105 dB, but higher levels are experienced in well, tank, and hangar decks. The noise spectrum in a space depends on the noise spectrum from each source and the relative level between sources. A space that has more than one noise source, therefore, has a different spectrum depending on which noise sources are active. On the other hand, several spaces can be dominated by one noise source.

The shipboard loudspeakers to be controlled by the ALC (LS-305 (1 watt), LS-387 (7.5 watts), NT49546 (10 watts), and the LS211/AIC-13 (20 watts)) vary considerably in output level, directionality, and frequency response. These differences, however, should not create problems for the ALC, if the speech intelligibility is acceptable and the alarms are audible during the highest noise periods.

Announcement/alarm characteristics were evaluated. The average announcement and all alarms are short in duration, about 15 seconds or less. The highest alarm rms levels and the speech peak levels are usually adjusted to the maximum line level (70.7 V or 12.2 V) and sometimes lower.

The optimum noise sensing microphone spectral characteristics depend on the noise spectrums being sensed. Since shipboard spectrums are not predictable or constant, the center speech frequencies were selected as the noise sensing microphone's frequency range. The ALC reaction to noise in this frequency range is to adjust the loudspeaker levels for minimum noise masking of speech while ignoring noise level variations outside this frequency range.

Electronics

The electronic parameters that form the basic ALC design are: charge and discharge times, signal voltage activation levels, feedback avoidance, input filtering, and controlled power levels.

The noise sensing circuits charge and discharge times were chosen to serve several purposes:

(1) create a quasi rms detector circuit,

(2) minimize reaction to transients, and

(3) bias the output toward the high side in widely varying noise fields.

The signal operated switch circuit charge time minimizes reaction to audio line noise spikes. The discharge time prevents the relays from clicking in and out during speech pauses and allows the noise sensing circuit time to minimize the effect of sensing announcements/alarms as noise.

The signal operated switch circuit's voltage activation level, must be a threefold compromise with:

(1) the need to minimize reaction to audio line noise,

(2) the need to minimize initial consonant losses (as much as 30 dB below maximum peak values), and

(3) the need to properly activate both 70.7 and 12.2 volt line ALCs.

Feedback must be avoided during announcements, to prevent the ALC from sensing the announcement as additional noise and thereby increasing the power to the loudspeakers. This increase would be sensed as a further increase in noise and so the ALC would increase the loudness again. The loudspeaker level increases would continue in a runaway fashion until the maximum loudness level was reached, without any fixed relationship to the ambient noise level, thereby defeating the ALC's purpose.

Electronic discrimination is one method to eliminate this feedback, but is not practical for shipboard applications because an electronic discriminator must have a fixed relationship between the sensor and the loudspeakers and have a potentiometer to compensate for slight variations. Both the fixed relationship and the potentiometer are not suitable shipboard requirements. A fixed level during the announcement/alarm is, therefore, the more suitable approach. The short announcements and the relatively stable noise levels make the fixed level approach quite acceptable.

The inputs to both the noise sensing and the signal operated switch circuits must be filtered to minimize reaction to line noises. The major line noises present on the noise sensing microphone line are signals induced by microphone vibration. The possible audio line noises are radio, radar, or 60-hertz induced signals.

The load to be controlled by the ALC must complement the loudspeaker requirements. The 12.2 volt line ALC is to control only one 20 watt amplifier-loudspeaker unit; therefore, the load circuit is predetermined. All loudspeakers in a space equipped with a 70.7 volt line system are to be ALC controlled. Most engineering spaces have one to four 7.5 watt loudspeakers. Very large spaces such as hangar, tank, and well decks have more than twenty 7.5 watt loudspeakers. However, these loudspeakers are connected together in groups of four or five to one of several distribution lines to protect against catastrophic communication losses. Each ALC, therefore, is required to control approximately a 40 watt loudspeaker load, with a separate ALC to control each group.

Packaging

Considerable attention was given to the ALC packaging since the acceptance by the Fleet could depend on packaging. The component integrity and accessibility, maintainability, systems safety, logistics and minimal costs are considered major packaging design requirements. Detailed requirements are presented below.

1. The enclosure must be drip-proof, but not watertight since temperature changes cause condensation within watertight enclosures.
2. The enclosure and component mountings must be reinforced to sustain the shock test.
3. Construction must be modular to meet maintainability requirements.
4. The 70.7 V and 12.2 V line ALCs must have common modules to minimize construction costs and logistics.
5. Cabling must be minimized to meet reliability and maintainability requirements.
6. Modules and terminals must be highly accessible during installation and maintenance.
7. Studs and quick connect terminals must be used to minimize installation and module replacement time.
8. All ALC components, including on-off switch and indicating fuse holder, must be enclosed to minimize tampering and physical damage.
9. System safety, which includes rounded corners, physical isolation of the 115 volt line and terminals, and proper labeling must be observed.
10. Extra terminals must be provided within the ALC to serve as a self-contained junction box.

Personnel

Shipboard personnel requirements must not be impacted by ALC maintenance requirements. Additional personnel, therefore, should not be required by skill level or maintenance time.

SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The automatic loudspeaker control senses the ambient noise in an area or a space and adjusts the input level to the appropriate loudspeakers to maintain a 0 to +12 dB signal-to-noise ratio in the space. The ALC operates by attenuating the signal level to the loudspeakers in 6 dB steps which correspond to equal changes in the ambient noise level as sensed by the ALC. The audio signal goes through the ALC without any attenuation whenever the sensed A-weighted noise level is above 100 dB (±6 dB depending on the howler input selection). The ALC therefore, is most effective in spaces or areas in which the ambient level varies at least 12 dB (two steps) and the highest expected A-weighted noise level is between 94 and 118 dB.

Two similar but distinct ALCs are available one for a central amplifier system with a 70.7 volt distribution line and one for a distributed amplifier system with a 12.2 volt distribution line. Both ALCs have a noise sensing microphone, noise sensing circuit, signal operated switch, level decoder, and built-in test equipment (BITE). The 70.7 volt line ALC has a relay-transformer circuit and a power supply. The 12.2 volt line ALC has relay-attenuator and voltage regulator circuits. Functional diagrams for the 70.7 volt line and the 12.2 volt line ALCs are shown in figures 1 and 2, respectively. Circuit connections for the respective ALCs are shown in figures 3 and 4.

SYSTEM STRUCTURE

The ALC is composed of the following elements.

Noise Sensing Microphone

The noise sensing microphone is presently used by the Navy as an extension howler for shipboard sound powered telephone stations. As an ALC microphone, the howler converts the ambient noise into an ac voltage which is detected by the noise sensing circuit.

Noise Sensing Circuit

The noise sensing circuit produces an analog signal proportional to the rms value of the detected noise. This analog signal continually updates the level decoder.

Signal Operated Switch Circuit

The signal operated switch circuit detects the presence of a signal on the audio distribution line and activates the transmit mode of the level decoder whenever a signal is sensed.

Level Decoder Circuit

The level decoder circuit constantly digitizes the noise signal from the noise sensing circuit. When the transmit mode is activated by the signal operated switch

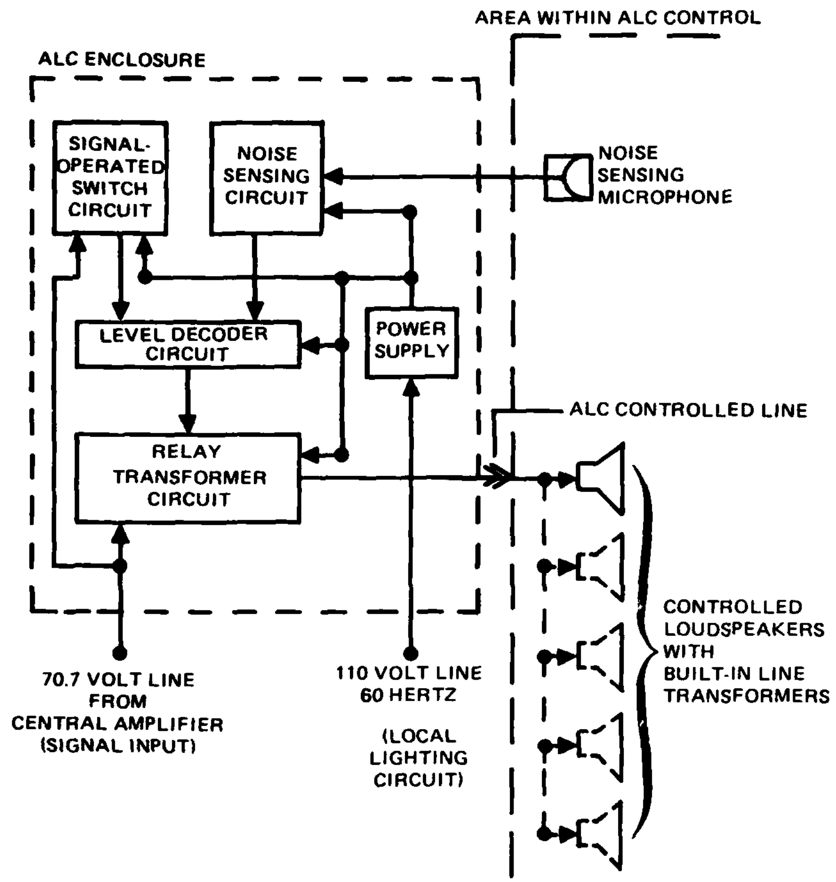


Figure 1. Functional block diagram of 70.7 volt line ALC controlling one to five loudspeakers.

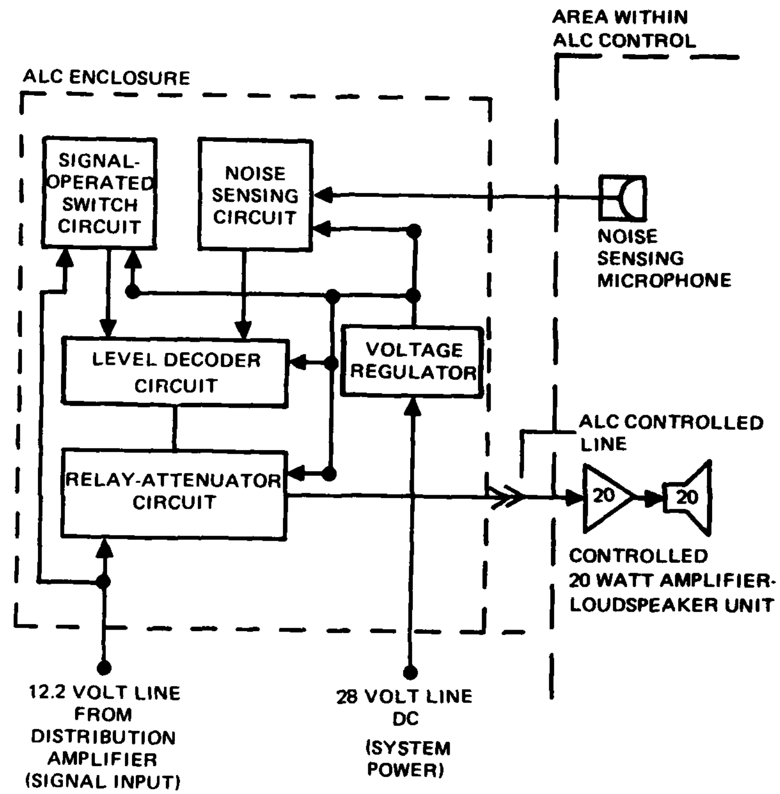


Figure 2. Functional block diagram of 12.2 volt line ALC controlling a 20 watt amplifier-loudspeaker unit.

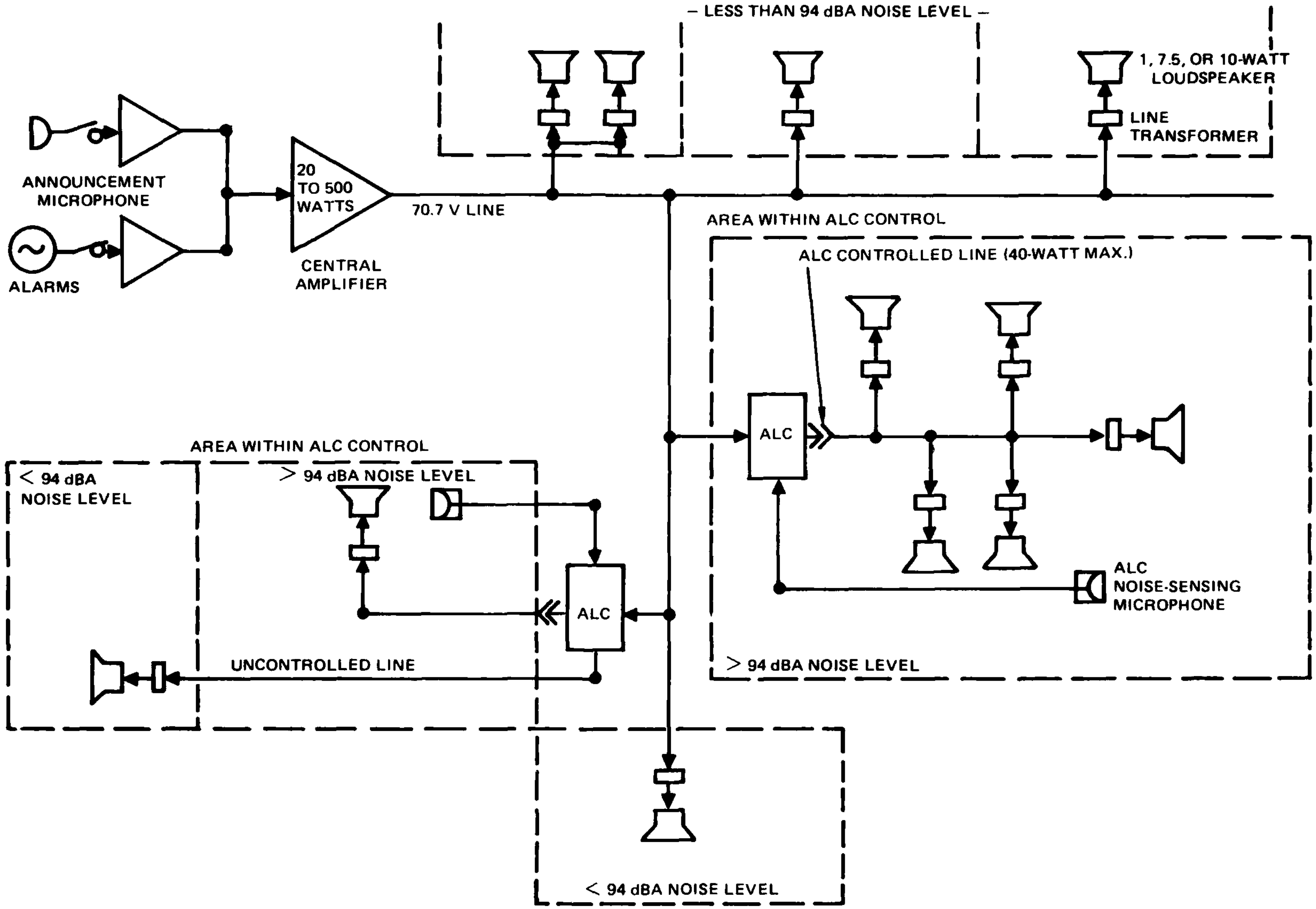


Figure 3. Functional diagram of 70.7 volt line central amplifier system with ALCs controlling single and multiple 1, 7.5, or 10 watt loudspeakers.

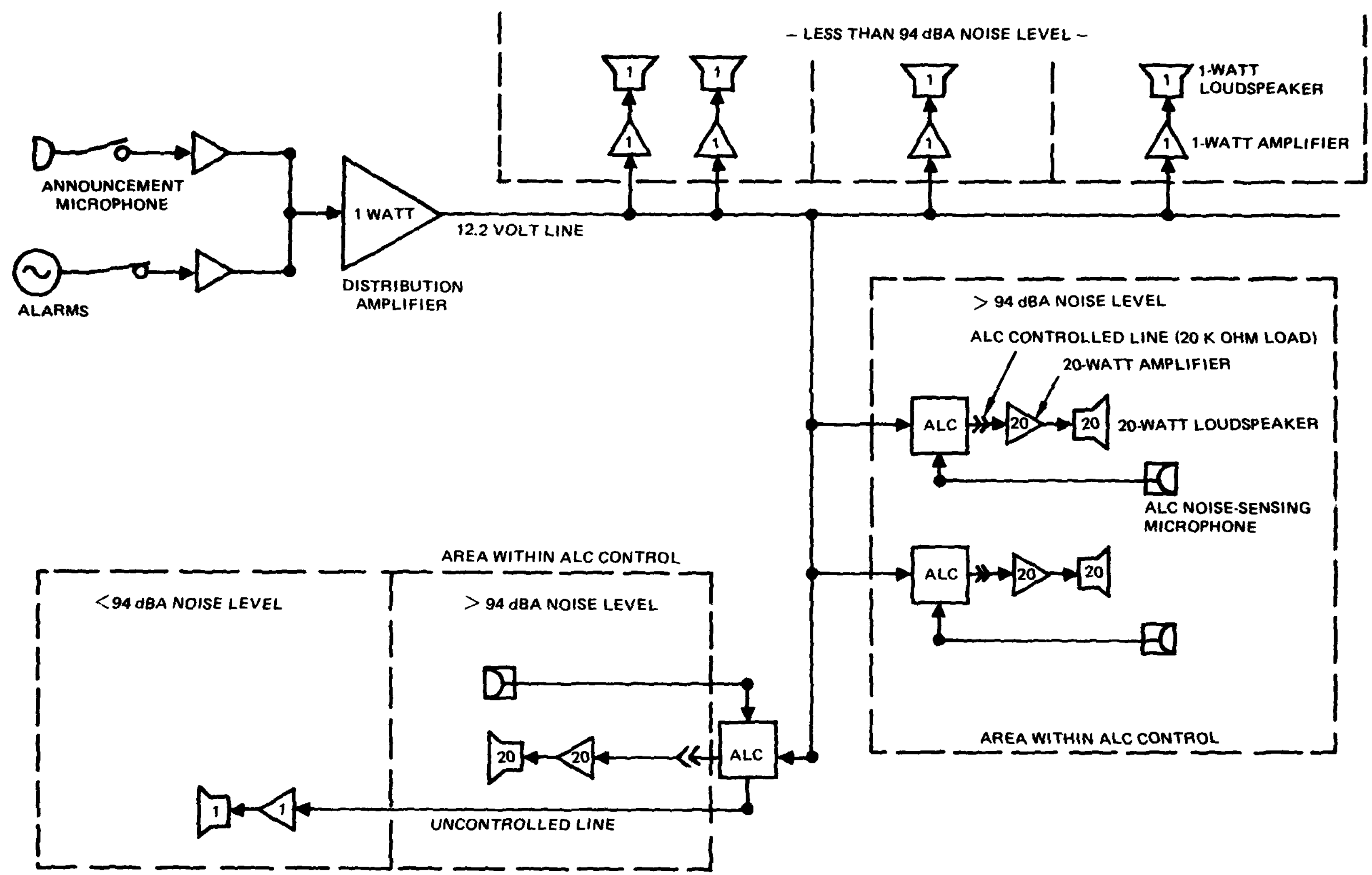


Figure 4. Functional diagram of 12.2 volt line distributed system with ALCs controlling single 20 watt amplifier-loudspeaker units.

circuit, the level decoder circuit stores the digital equivalent of the latest noise level in a latch. The latch output is fed into the relay-transformer in the 70.7 volt line ALC or relay-attenuator circuit in the 12.2 volt line ALC.

Relay-Transformer Circuit

The relay-transformer circuit connects the 70.7 volt line from the central amplifier to the controlled loudspeaker(s) at a power level that produces a predetermined signal-to-noise ratio.

Relay-Attenuator Circuit

The relay-attenuator circuit connects the 12.2 volt line from the distribution amplifier to a single 20 watt amplifier-loudspeaker unit at an input level that produces a predetermined signal-to-noise ratio.

The power supply for the 70.7 volt line ALC converts ac line power to required dc levels. The voltage regulator for the 12.2 volt line ALC converts the dc line power to required dc levels.

BITE Circuit

The built-in test equipment (BITE) circuit tests each component and each circuit's operation. The BITE provides for preventive maintenance and fault location. The preventive maintenance procedure checks circuit tolerances,timing, and operation. The fault location procedure isolates the defective module with a 15-minute predicted mean-time-to-replace by an IC3[3] or higher rated technician. The BITE and available test points allow the technician to isolate defective components, so that shipboard repair of the circuit boards is possible; however, repairs are planned to be performed at a depot.

SYSTEM FUNCTION

Noise Sensing Microphone

The noise sensing microphone is bulkhead mounted remote from the ALC enclosure and must be placed in the space or area being controlled by the ALC. The microphone, a shipboard extension howler, consists of a sound powered telephone transducer with an 850 to 2100 hertz bandwidth. The ambient noise sensed by the microphone generates a low level ac voltage which is the input to the noise sensing circuit.

Noise Sensing Circuit

The noise sensing circuit detects the microphone voltage with a charge time of 1.9 seconds and a discharge time of 6.2 seconds, which is a quasi-rms detection circuit. The noise sensing circuit output is a dc voltage used to operate the level decoder. This voltage is directly proportional to the noise.

3. Interior Communications Electrician Third Class (IC3), per Section I, Navy Enlisted Occupational Standards, NAVPERS 18068D, Sept 1975.

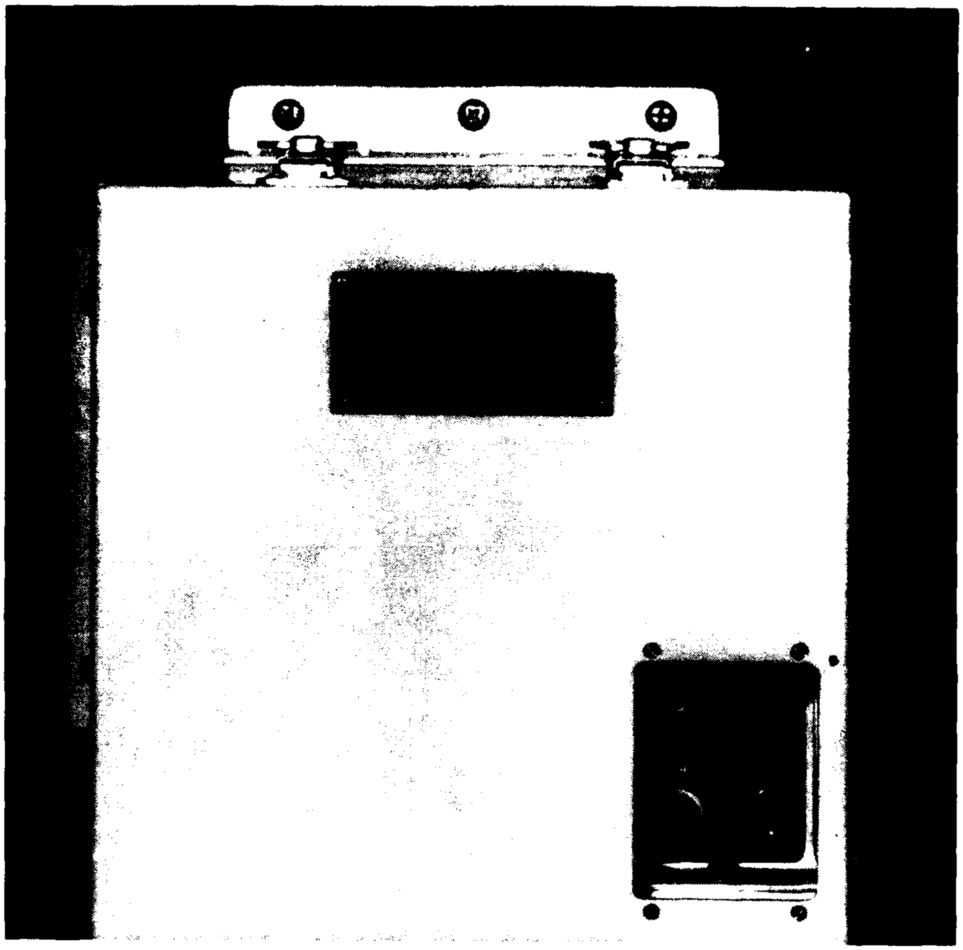


Figure 5(a). C-10756/SIC ALC front view.

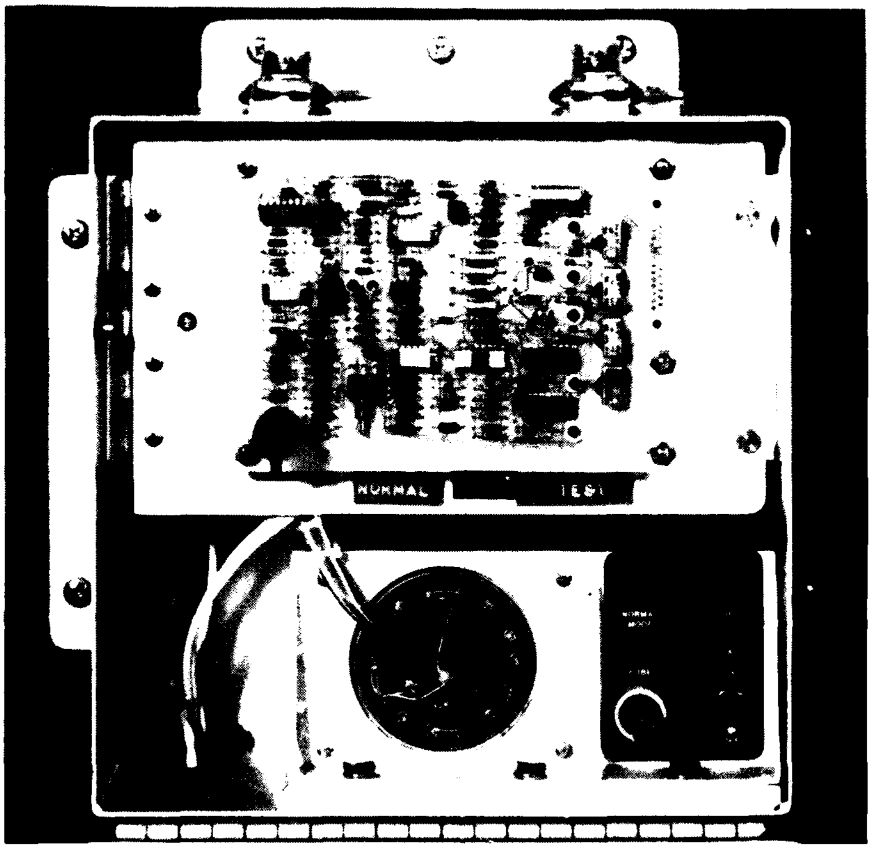


Figure 5(b). C-10756/SIC ALC cover opened.

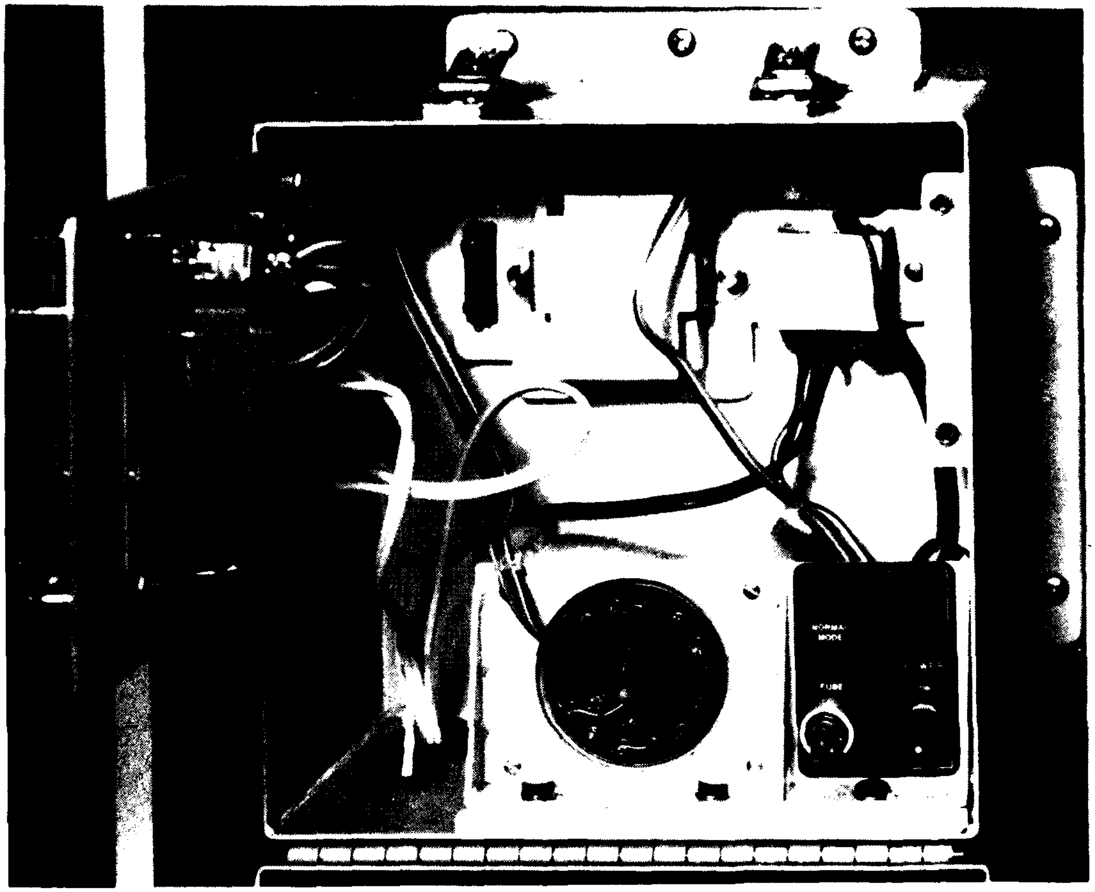


Figure 5(c). C-10756/SIC ALC, circuitboard opened.

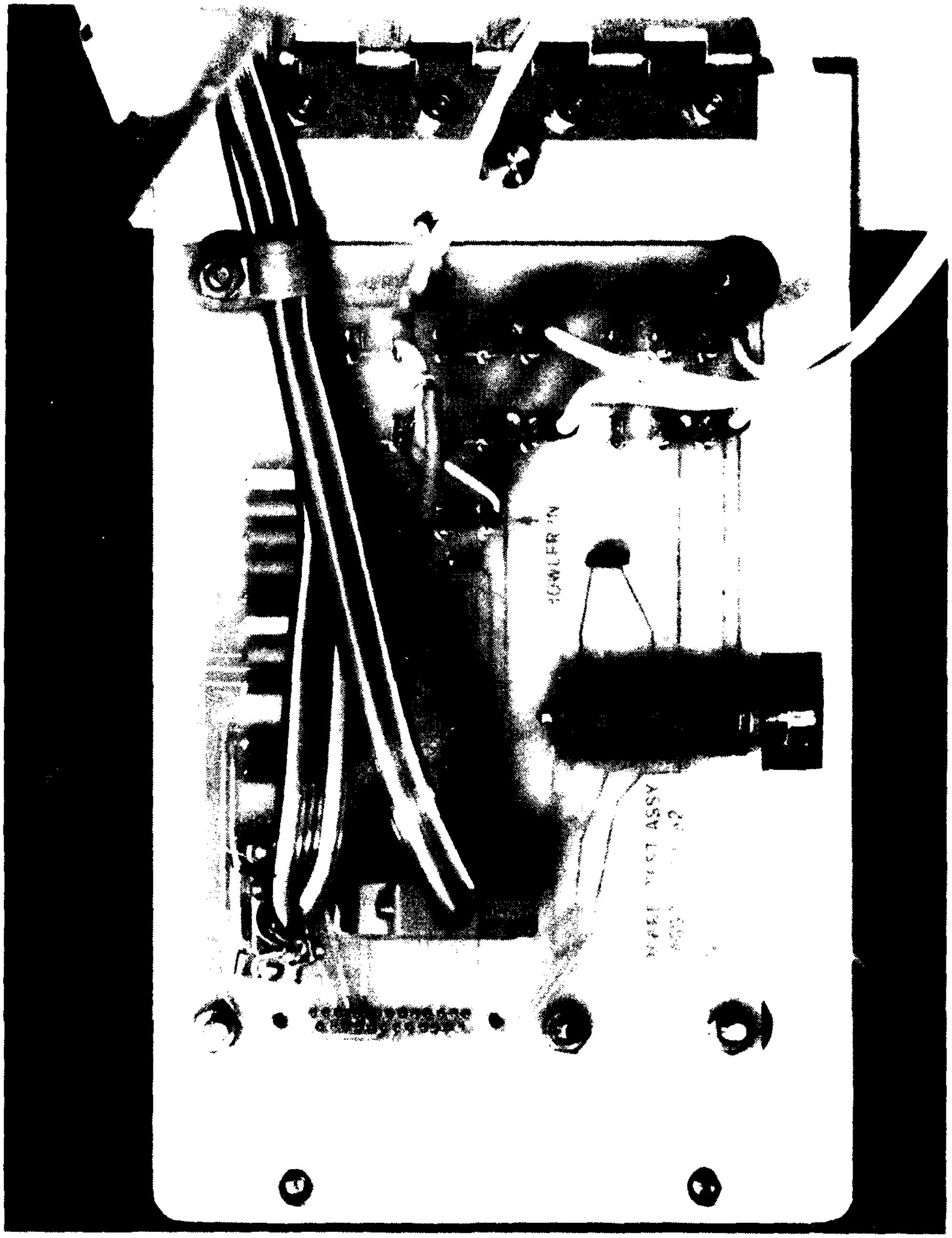


Figure 5(d). C-10756/SIC ALC interface card.

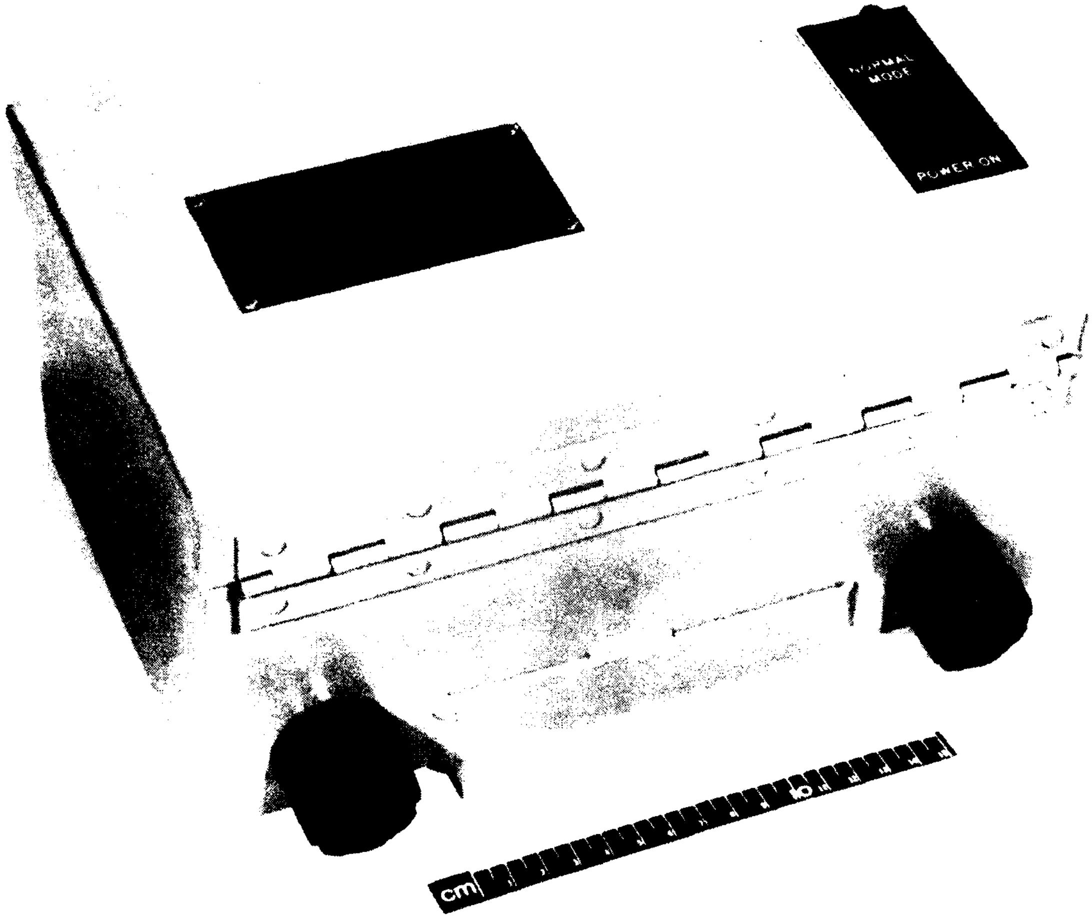


Figure 6(a). C-10757/WIC ALC front view.

Figure 6(b). C-10757/WIC ALC cover opened.

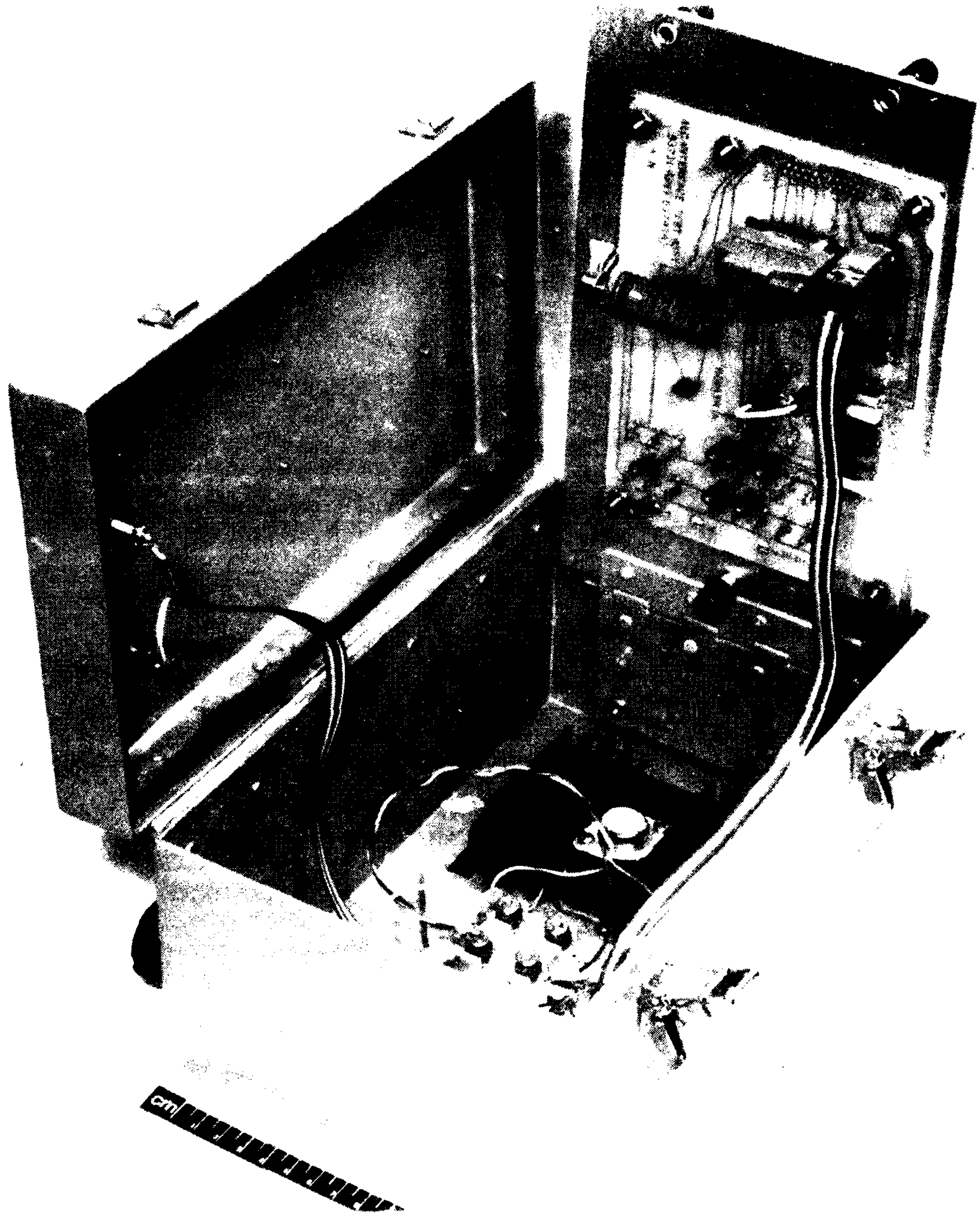


Figure 6(c). C-10757/WIC ALC circuit board opened.

Signal Operated Switch Circuit

The signal operated switch circuit senses the presence of an audio signal on the 70.7 or 12.2 volt line and activates the level decoder circuit, from the signal transmission onset to 10 seconds after the signal cutoff.

Level Decoder Circuit

The level decoder circuit digitizes the analog noise-measure voltage into one of five possible loudness levels which correspond to sensed noise levels of <82, 82–88, 88–94, 94–100 and >100 dB referenced to 20 micropascals. When activated by the signal-operated switch circuit, the last decoded level is stored and maintained until released by the signal operated switch circuit. The level decoder circuit output controls the 70.7 volt line relay transformer circuit or the 12.2 volt line relay-attenuator circuit.

70.7 Volt Line Relay-Transformer

The 70.7 volt line relay-transformer circuit selects the power level for the controlled loudspeaker(s). Circuitry, which actuates four relays and five LEDs, is enabled by the signal operated switch circuit and is controlled by the level decoder circuit. A multi-winding transformer supplies power levels to the loudspeakers 6, 12, 18 or 26.5 dB below full power, as selected by a relay. Full power, which bypasses the transformer, is selected when all relays are deactivated. The ALC, therefore, fails safe with full power to the loudspeaker(s) if ac power is lost.

12.2 Volt Line Relay-Attenuator Circuit

The 12.2 volt line relay-attenuator circuit selects the power level for the controlled amplifier-loudspeaker. This circuit is identical to the 70.7 volt line relay-transformer circuit except for a resistive step attenuator that replaces the transformer. The relays select one of the four attenuator steps which reduces the power to the amplifier-loudspeaker by 6, 12, 18 or 24 dB below full power.

70.7 Volt Line ALC Power Supply

The power supply for the 70.7 volt line ALC operates on the 110 volt 60 hertz line, which is obtained from a local lighting circuit.

12.2 Volt Line ALC Voltage Regulator

The voltage regulator for the 12.2 volt line ALC operates on the 28 volt dc line, which is obtained from the amplifier-loudspeaker unit.

The Built-in Test Equipment (BITE)

The built-in test equipment tests the operation and tolerances of each ALC circuit and the noise sensing microphone. The BITE is operated by throwing the "test/normal" switch to "test," which connects the audio line directly to the loudspeakers, bypassing the ALC; connects power to the BITE; and applies a test signal to the input of the signal-operated switch circuit.

A twelve-position BITE switch activates the next tests. All electronic circuit integrity, including relay coils and contacts and the transformer or step attenuator, is verified by a "loop-back" test. A runaway phenomenon is produced by switching the latch strobe input from the strobe line to ground and connecting a test signal through the relay-transformer or relay-attenuator circuit back to the noise sensing circuit input to close the loop, hence "loop-back." The ALC responds as if this signal were noise at a level between 82 and 88 dB and increases the signal level from the relay circuit. The noise-sensing circuit responds to the increase and so on, until the maximum level is reached. If the ALC is working properly, therefore, all the relays and the five level-indicating LEDs (which are easily observed) are activated in sequence. The BITE switch is advanced to remove the test signal. The reverse sequence is then observed as the noise sensing circuit discharges. The relay selection level accuracy is checked by observing the level-indicating LEDs while stepping the BITE switch through eight positions.

Throwing the toggle "howler test/self test" switch to "howler test" connects the noise-sensing microphone and its cable as one arm of a resistance bridge, which is driven by a test signal. If the microphone and cable are operational, the bridge is balanced, thereby causing an LED to light. The resistance bridge circuitry is checked in the "self test" switch position by substituting a resistor for the microphone in the bridge.

A yellow LED verifies signal-operated switch circuit operation. When the "test/normal" switch is thrown back to "normal," the yellow LED should remain lit for 10 seconds, verifying the signal-operated switch circuit release time.

System Interconnection

The 70.7 volt line and the 12.2 volt line ALCs have as many common components and assemblies and as little hand wiring as practical. The common ALC circuitry and the BITE are mounted on one circuit card assembly. An interfacing printed circuit board, which plugs directly into the circuit card assembly, contains the audio line input/output terminals; noise sensing microphone level selection and input terminals; dc input connector (P_1) from the power supply or voltage regulator; transformer/step attenuator connector (P_2); ten test points; and the "test/normal" switch.

Input and output connections to the interfacing board consist of crimped, slip-on lugs. Both boards are mounted back to back on a hinged section which is released by two thumb screw fasteners and locked in the open position by a third thumb screw fastener. The power supply is mounted to the rear with protected but probeable terminals. The transformer is mounted to the bottom with its terminals facing forward for easy probing. The power supply and transformer are connected to the printed circuit board at P_3 and P_2, respectively, by connector terminated cables. The voltage regulator circuit is mounted to the rear and connected to the printed circuit board at P_1 by a connector terminated cable. The step attenuator is wired directly to a connector which plugs into P_2 on the printed circuit board. The "on/off" switch, the indicating fuse, and the "power" and "normal mode" lights of the 70.7 V line ALC are mounted in the bottom corner behind a see-through section of the front panel. The "power" and "normal mode" lights of the 12.2 V line ALC are mounted on the front cover. The power terminals are next to the power supply or voltage regulator. The input and output cables enter the enclosure through stuffing tubes mounted in the bottom. The front panel hinges on the bottom and locks with two hasps on the top. The enclosure mounting holes are exterior to the ALC. These features are shown in figures 5 and 6.

PERSONNEL SUPPORT

Preliminary indications are that no additional personnel will be required to support the ALC on board Navy ships. According to an analysis by the Personnel and Training

Analysis Department of the Naval Sea Support Center, Pacific (see appendix F), the ALC operation and maintenance should place a minimum workload requirement on existing shipboard technicians. Skills and knowledge required fall within Navy IC3 technician qualifications with on-the-job-training for ALC operation and maintenance.

TECHNICAL SPECIFICATIONS

This specification covers both 70.7 and 12.2 volt line ALCs which attenuate audio signals to announcing/alarm system loudspeakers in respect to ambient noise levels. These ALCs are easy to install and maintain and are resistant to shipboard environmental conditions.

Functions	Characteristics
• Control Method	Attenuation [0 dB to 24 or 26.4 dB attenuation in 6 dB steps (one 8.4 dB step)]
• Circuit Modes	Operating – "Normal" BITE – "Test"
• 0 dB Attenuation Conditions	– "Normal" mode (for A-weighted noise levels above 100 ±6 dB) – "Test" mode – Deenergized – Common failures
• Grounds	– Case – Signal (isolated from case)
Signal Sensing Characteristics	
• Signal onset time	12 milliseconds (MAX)
• Signal release time	10 ±2 seconds
• Signal level for activation	
– Nominal	1.0 volts rms sinewave
– Maximum	1.3 volts rms sinewave
Noise Sensing Characteristics	
• Noise attack time (to max. noise level)	6 ±2 seconds
• Noise release time (from max. noise level)	15 ±2 seconds
• Noise input sensitivity (min.) 0 dB attenuation condition	

Input Selection	Min. Noise Input Sensitivity
Normal	45 mV
–6 dB	90 mV
+6 dB	22.5 mV

Output Level to Loudspeakers for Sensed Noise Levels

Output level/ input audio line level in dB		A-weighted noise levels at "Howler" in dB (Noise Sensitivity Selection)		
70.7 V line	12.2 V line	(normal)	(–6 dB)	(+6 dB)
0	0	100	106	94
–6	–6	94	100	88
–12	–12	88	94	82
–18	–18	82	88	76
–26.4	–24	<82	<88	<76

- Output to input signal ratio tolerance — ±1.5 dB (no load to load for 70.7 volt line ALC) (20 k ohm load for 12.2 volt line ALC)

Output Power

- Controlled audio power (max.)
  - –70.7 V line ALC — 40 watt continuously duty cycled 1 minute on/4 minutes off
  - –12.2 V line ALC — 20 k ohm load

Input Power

- Voltage source
  - –70.7 V line ALC — 115 V ac, 60 or 400 Hz single phase
  - –12.2 V line ALC — 14 to 35 V dc

Power drain –	70.7 V line ALC	12.2 V line ALC
– Standby	0.4 watts	1.1 watts at 28 V dc
– Max. operating conditions	1.8 watts	3.4 watts at 28 V dc

Bite Characteristics

- Switching characteristics tests
  - – Relay selection level tolerance test — +1 to –2 dB
  - – Noise charge time each level (approx.) — 2 seconds
  - – Noise discharge time each level (approx.) — 6 seconds
- Switched signal circuits and noise-sensing circuit — Loopback test – from maximum to minimum attenuation through each intervening level.

- Signal operated switch circuit
  - Verification of operation — Yellow LED
  - Release time (approx.) — 10 seconds
- Noise-sensing microphone and cable impedance test — 360 to 1850 ohms (nominal)

Noise-Sensing Microphone Characteristics

- Sensitivity (nominal) — 17 mV/pascal
- Impedance — 1000 ohm ±20%
- Frequency range — 850 to 2100 Hz
- Vibration sensitivity (max.) — 4 mV for 0.2g at resonance (approx. 900 Hz)

Other Characteristics

- Maximum dimensions

Description	Height	Width	Depth	Weight
70.7 V line ALC	(32 cm) 12 1/2"	(33 cm) 13"	(18.5 cm) 7 1/4"	(8.2 kg) 18 lbs.
12.2 V line ALC	(23.5 cm) 9 1/4"	(27.9) 11"	(15.9 cm) 6 1/4"	(3.3 kg) 7 1/4 lbs.
Howler	(9.5 cm) 3 3/4"	(12.7 cm) 5"	(9.8 cm) 3 7/8"	(.5 kg) 1 lb.

- Reliability (Min.) — 20,000 hours M-T-B-F
- Maintainability (Max.)
  - Circuit card assembly or power supply only — 10 minute M-T-T-R
  - Entire ALC with five loud-speakers connected — 15 minute M-T-T-R
- Installation time (not including bracket or extra cabling, if necessary) — 15 minutes

Environmental Specifications

- Temperature — MIL-E-16400 Range 4 (0-65°C)
- Humidity — MIL-E-16400 (one cycle with front panel open)
- Vibration — MIL-STD-167-1 Type 1
- Shock — MIL-S-901, Grade A, Type A, Class 1
- Enclosure — Drip-proof (45°) IAW MIL-STD-108
- Salt spray — MIL-E-16400 (sheltered equipment)

INSTALLATION CRITERIA

Automatic loudspeaker control (ALC) installers must know the maximum noise levels and the maximum loudspeaker output signal levels at the work stations before installing an ALC. Signal and noise level predictions do not have the necessary precision; therefore, actual sound level readings under operating conditions are required. A sound level meter set to read "A-weighted" levels with "fast" damping is needed to measure the noise levels at the work station and at the proposed location of the ALC noise sensing microphone, and the output levels from the loudspeakers in the work station area.

The signal and noise levels should meet certain criteria. Measured work station speech signal-to-noise ratios under maximum noise conditions should fall between 0 and +12 dB. The maximum noise levels at the work station should fall between 94 and 118 dB. The noise level at the ALC noise sensing microphone should not be either more than 5 dB below or 15 dB above the noise level at the work station.

ALC installations that do not meet the above criteria can create very poor listening conditions at all noise levels. If the signal-to-noise ratio is not adequate at maximum noise levels, then the signal-to-noise ratio probably would not be adequate at any lower noise levels. If the noise level at the work station exceeds 118 dB but the signal-to-noise ratio is adequate, then at noise levels below 106 dB the signal level will be excessively high. If the noise level at the ALC microphone is either more than 5 dB below or 15 dB above the work station noise level, then the ALC would not change the loudspeaker levels at the appropriate work station noise levels.

Table 1 presents examples of typical conditions for applying the ALC within the above criteria. The first two columns state the possible prevailing conditions: the maximum noise level at the work station and the signal-to-noise ratio at the work station when the noise level is maximum. The other columns give the recommendations: the location of the ALC noise sensing microphone, the noise level at the ALC microphone relative to the noise level at the work station, the ALC noise sensing microphone input selection, and comments on the desirability of each particular set of conditions.

Table 1. Conditions for mounting and connecting noise-sensing microphone.

Prevailing Conditions		Recommended Microphone Location and Input to ALC			
Maximum Noise Level at Work Station	S/N at Work Station at Maximum Noise Level	Location of ALC Noise-Sensing Microphone	Noise Level at Mike Relative to Noise Level at Work Station (or Noise Level at Mike)	ALC Input Selection for Mike	Comments
dBA	dB		dB (dBA)	dB	
> 118	> 0	–	–	–	ALC not designed to operate above 118 dBA.
113-118	0 to +2	On bulkhead near work station	0 to +4	-6	
107-112	0 to +2		0 to +4	0	
101-106	0 to +2	On bulkhead near work station	0 to +4	+6	
		or close to noise source*	+5 to +10	0	Good use of ALC Installer should improve S/N if possible.
			+11 to +15	-6	
94-100	0 to +2	Close to noise source*	+5 to +10	+6	
			+11 to +15	0	
< 94	0 to +2	Close to noise source*	(94 to 100)	+6	Poor use of ALC.
106-115	+3 to +6	On bulkhead near work station	0 to +4	-6	
101-106	+3 to +6	On bulkhead near work station	0 to +4	0	Optimum conditions for ALC usage.
		or near noise source*	+5 to +10	-6	
94-100	+3 to +6	On bulkhead near work station	0 to +4	+6	Excellent conditions for ALC usage.
		or near noise source*	+5 to +10	0	
			+11 to +15	-6	
< 94	+3 to +6	Close to noise source	(94-100)	+6	Use only if ALC is a must.
101-111	+7 to +12	On bulkhead near work station	0 to +4	-6	Optimum conditions for ALC usage.
		or far from noise source	-5 to -1	0	
94-100	+7 to +12	On bulkhead near work station	0 to +4	0	Excellent conditions for ALC usage.
		or far from noise source	-5 to -1	+6	
88-94	+7 to +12	On bulkhead near work station	0 to +4	+6	Use only if ALC is a must.
< 88	+7 to +12	–	–	–	ALC is not needed. Reduce output from loudspeaker(s) by 6 dB.

*Avoid mounting in high vibration area.

SYSTEM DOCUMENTATION

Naval Ocean Systems Center (NOSC) personnel have documented the Automatic Loudspeaker Control (ALC) to permit contracting for manufacture to print. A prototype specification and technical manual have also been provided. Nomenclature and labeling format have been formally requested and received.

The ALC documents supplied by NOSC are listed below.

a. Naval Sea Systems Command drawings 53711–5379389 through 53711–5379418

53711–	Assembly drawings
5379389	Automatic Loudspeaker Control Circuit Card Assembly
5379392	ALC Interface/Test Assembly Circuit Card Assembly
5379400	Automatic Loudspeaker Control Assembly C-10756/SIC, Surface
5379408	Automatic Loudspeaker Control Assembly C-10757/WIC, Submarine
5379405	"Howler" sound powered telephone element (for use with Automatic Loudspeaker Control)

b. Control, Automatic Loudspeaker, C-10756/SIC and C-10757/WIC, Specification for,

c. Control, Automatic Loudspeaker, C-10756/SIC and C-10757/WIC, Technical Manual.

SYSTEM DEPLOYMENT

Future plans include introducing the automatic loudspeaker control (ALC) into the fleet and possibly other services, and developing other versions for systems not compatible with the present ALC.

STANDARD FLEET USE

The ALC will be introduced into the fleet without any special program. The installing contractors will provide on-the-job training (OJT) to the responsible IC technicians. The ALC technical manuals will provide all necessary supporting information. A one or two hour lecture with an ALC trainer is planned for the Interior Communications Electrician Class "A" course, which will serve to introduce all new technicians to the ALC.

ALC installations are planned for all surface ship locations equipped with announcing circuits 1MC or 3MC with A-weighted noise levels above 94 dB and for all submarine locations equipped with 20 watt amplifier-loudspeaker units with A-weighted noise levels above 94 dB. The USS BELLEAU WOOD,(LHA-3) well deck is to have ALCs installed along with a new loudspeaker system this year during post-shakedown availability (PSA), which is the first planned ALC installation. Other LHAs are planned to have the ALCs installed during SHIPALTS.

NON-STANDARD FLEET USE

The two ALC models described in this report will operate in many, but not all, announcing systems. All specified parameters can be changed, although some more easily than others, to adapt the ALC to these other systems. For instance, two ALCs can be ganged to operate over a 48 dB range; also, the transformer and attenuator impedances and power handling capabilities can be changed.

One application under consideration is the flight deck announcing system, which must override A-weighted noise levels up to 140 dB, power 80-watt loudspeakers on a 95-volt distribution line, and react to rapid changes in noise levels.

OTHER APPLICATIONS

This report is being widely distributed to alert possible ALC users in various fields of communication. NOSC will issue a press release to the trade journals. NAVSEA personnel plan to write an article about the ALC for the NAVSEA Journal. NOSC and NAVSEA both plan to stimulate further interest by personal contacts.

APPENDIX A
AUTOMATIC LOUDSPEAKER CONTROL SCHEMATICS

A-1 Automatic Loudspeaker Control Circuit Card Assembly Schematic – NAVSEA Drawing 53711-5379391

A-2 C-10756/SIC Control, Automatic Loudspeaker Wiring Diagram – NAVSEA Drawing 53711-5379397

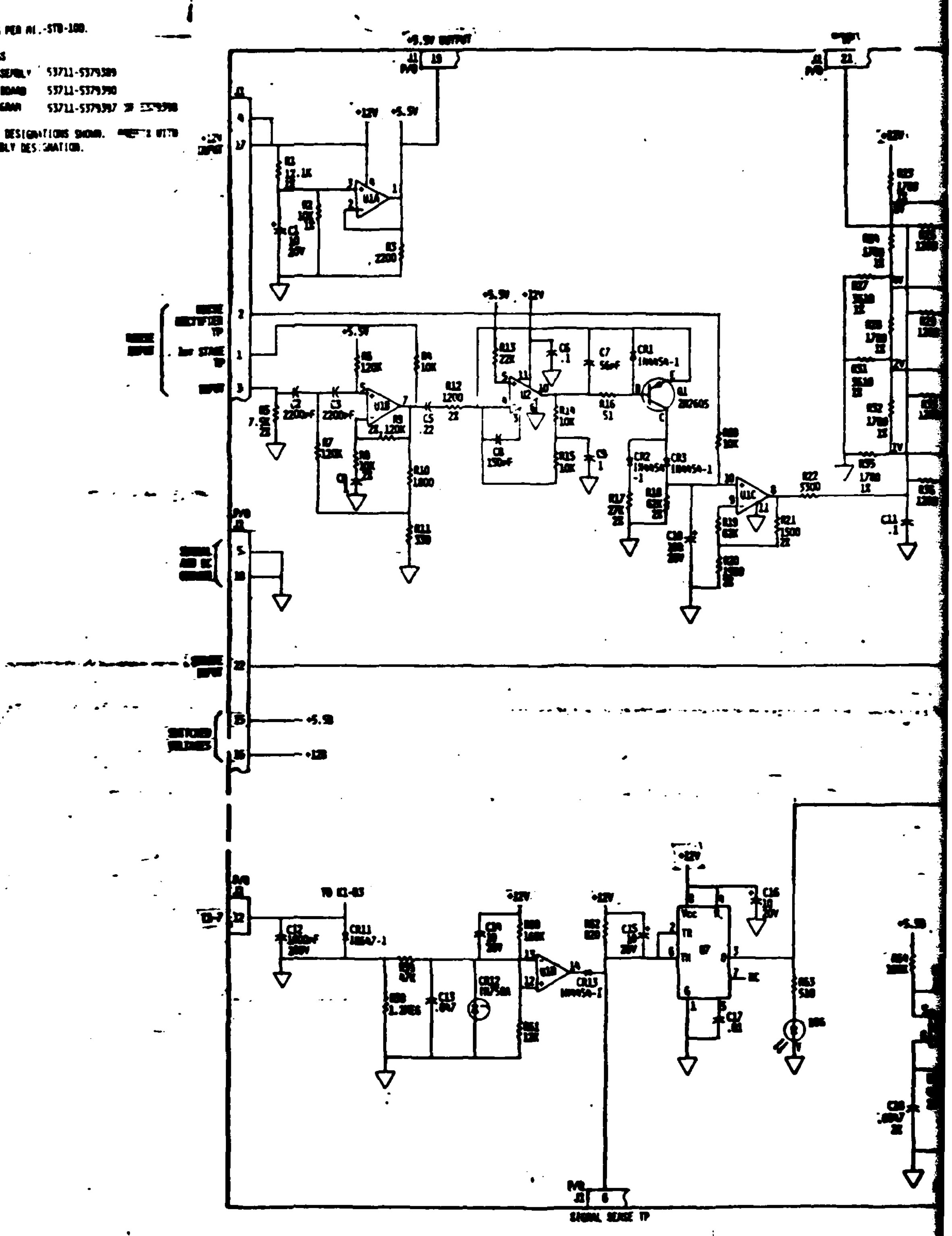
A-3 C-10757/WIC Control, Automatic Loudspeaker Wiring Diagram – NAVSEA Drawing 53711-5379398

NOTES:

1. SCHEMATIC DRAWING PER MIL-STD-100.

2. REFERENCE DRAWINGS
   - CIRCUIT CARD ASSEMBLY 53711-5379389
   - PRINTED WIRING BOARD 53711-5379390
   - UNIT WIRING DIAGRAM 53711-5379397 OR 5379398

3. PARTIAL REFERENCE DESIGNATIONS SHOWN. PREFIX WITH UNIT AND SUBASSEMBLY DESIGNATION.



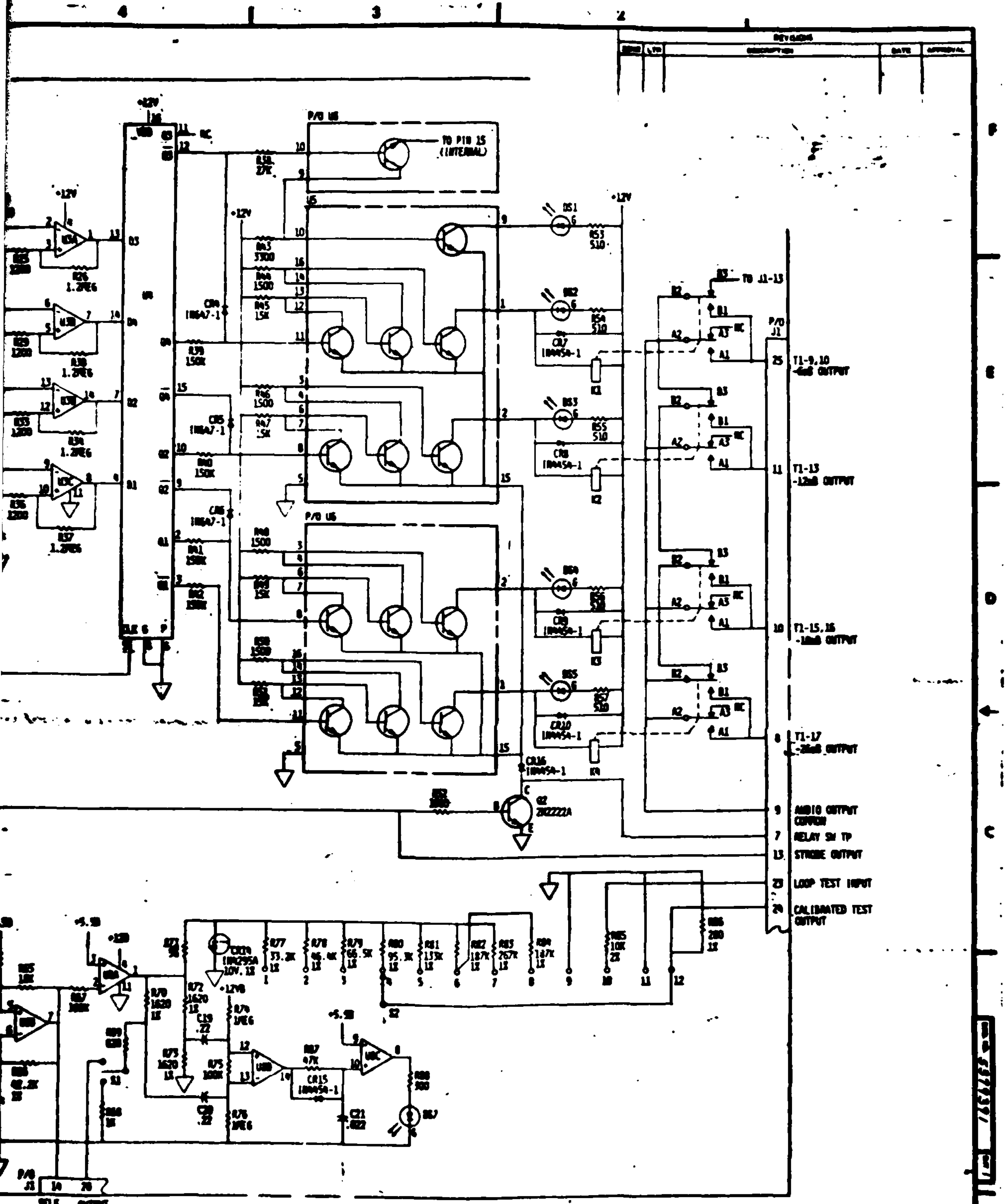
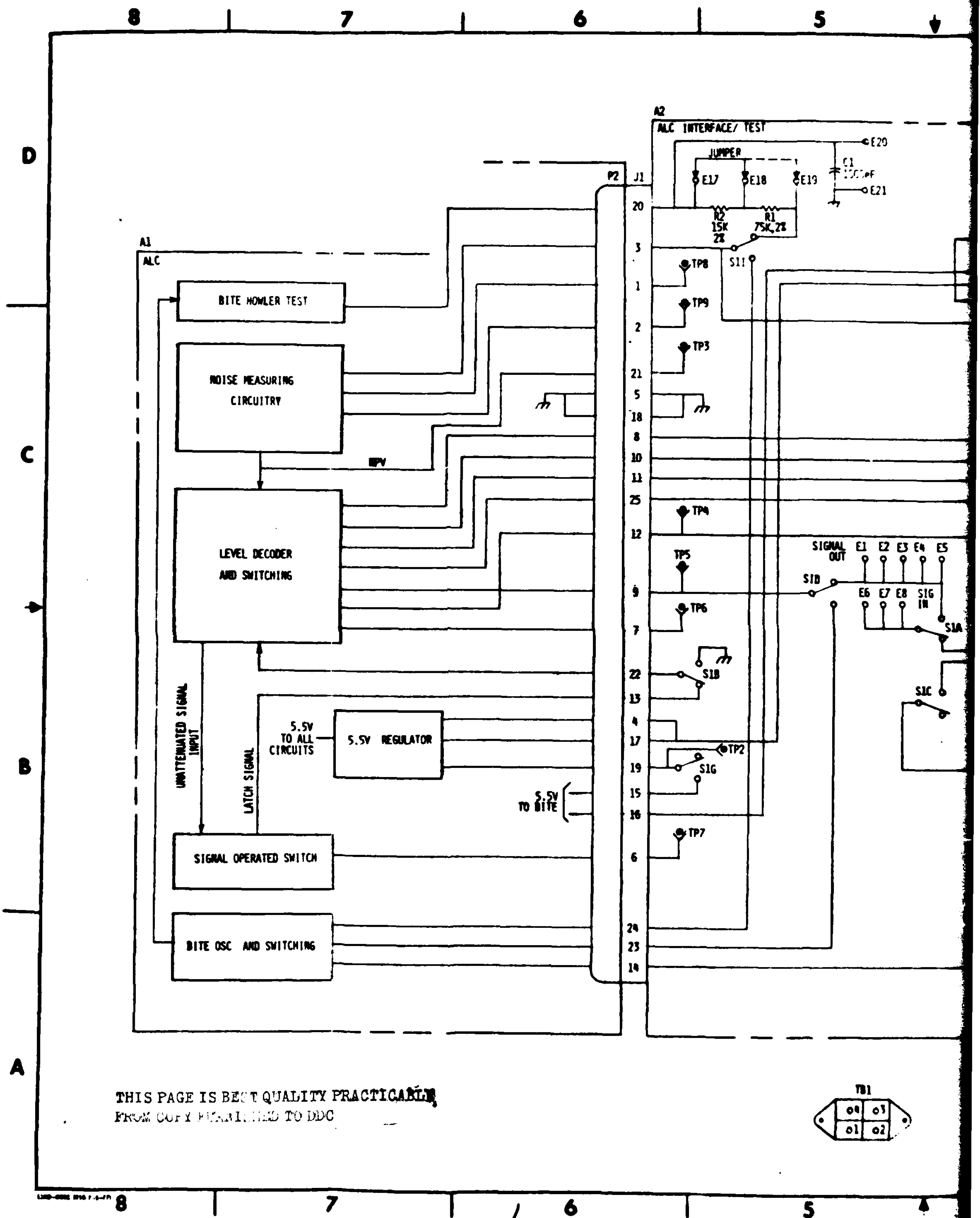


Figure A-1. Automatic loudspeaker control schematic diagram.

AUTOMATIC LOUDSPEAKER CONTROL - SCHEMATIC DIAGRAM

F 53711 5379391



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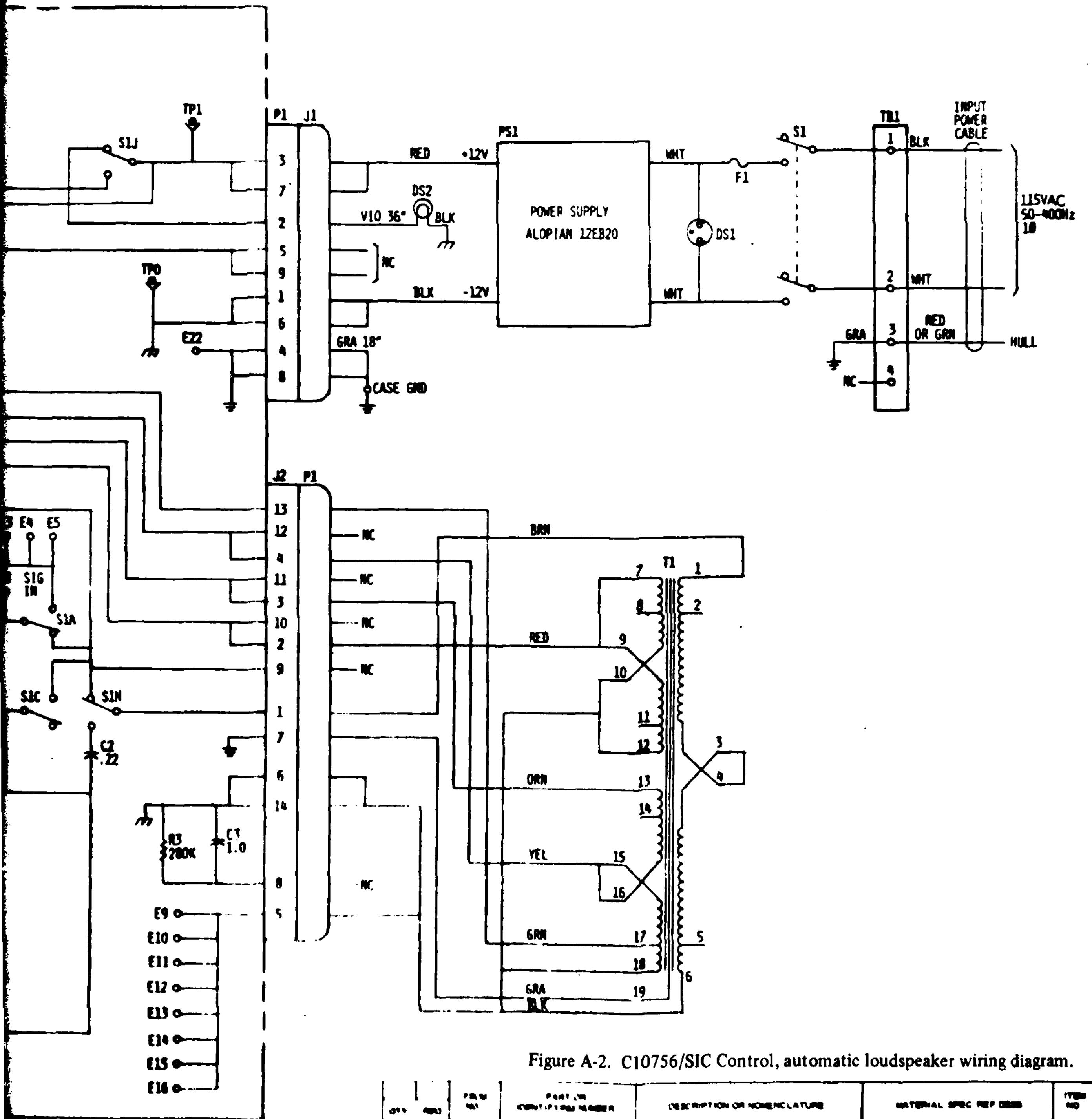


Figure A-2. C10756/SIC Control, automatic loudspeaker wiring diagram.

QTY		FSCM NO.	PART OR IDENTIFYING NUMBER	DESCRIPTION OR NOMENCLATURE	MATERIAL SPEC REF DSGN	ITEM NO

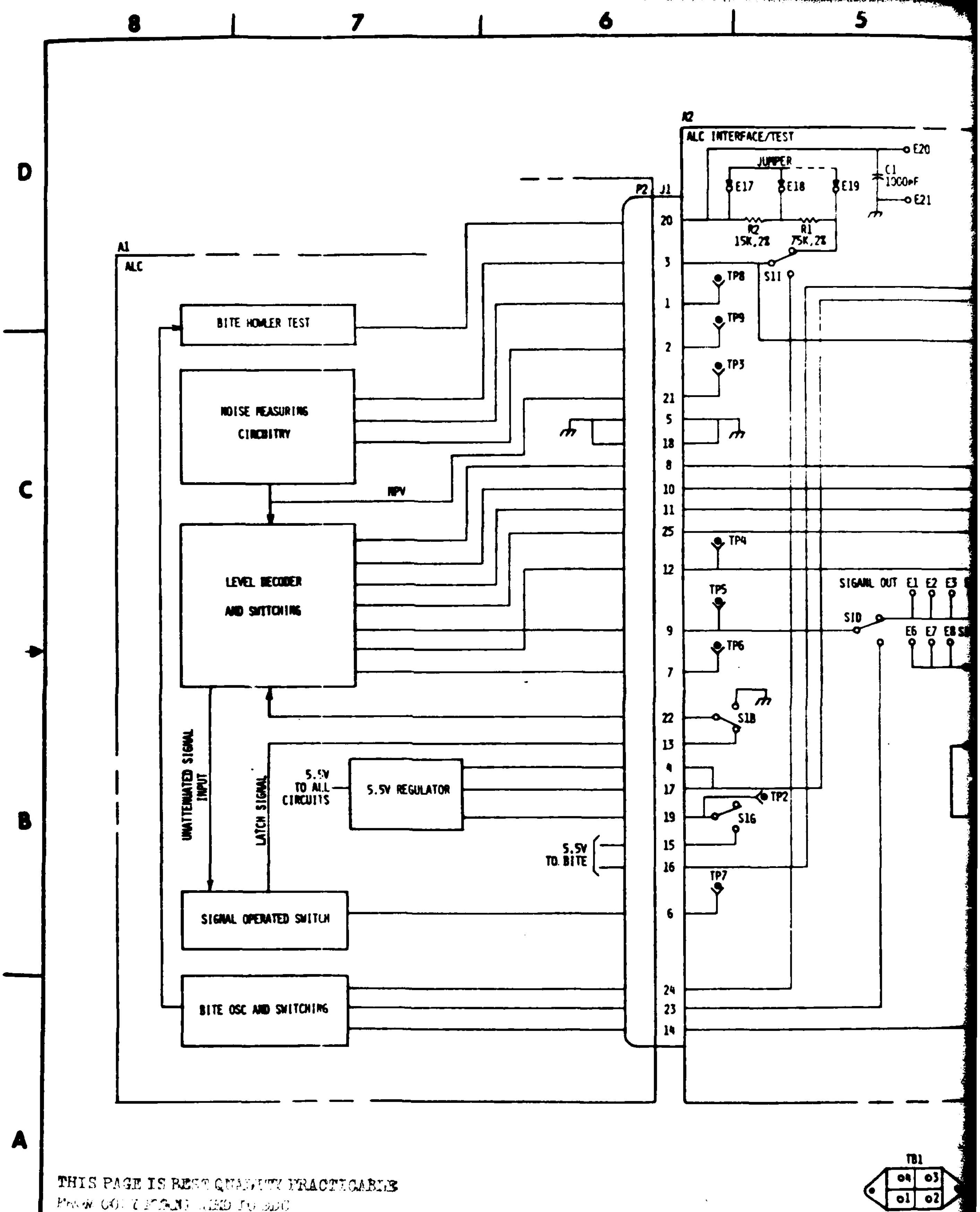
PARTS LIST

NAVAL OCEAN SYSTEMS CENTER

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, D.C.

C10756 / SIC
CONTROL, AUTOMATIC
LOUDSPEAKER -
WIRING DIAGRAM

D 53711 5379397


A1
ALC
BITE HOWLER TEST
NOISE MEASURING CIRCUITRY
NPV
LEVEL DECODER AND SWITCHING
UNATTENUATED SIGNAL INPUT
LATCH SIGNAL
5.5V TO ALL CIRCUITS
5.5V REGULATOR
5.5V TO BITE
SIGNAL OPERATED SWITCH
BITE OSC AND SWITCHING
P2
J1
A2
ALC INTERFACE/TEST
JUMPER
E17
E18
E19
E20
E21
C1 1000pF
R2 15K,2%
R1 75K,2%
S11
TP8
TP9
TP3
TP4
TP5
TP6
TP7
TP2
S1B
S16
S1D
SIGANL OUT
E1
E2
E3
E6
E7
E8
TB1

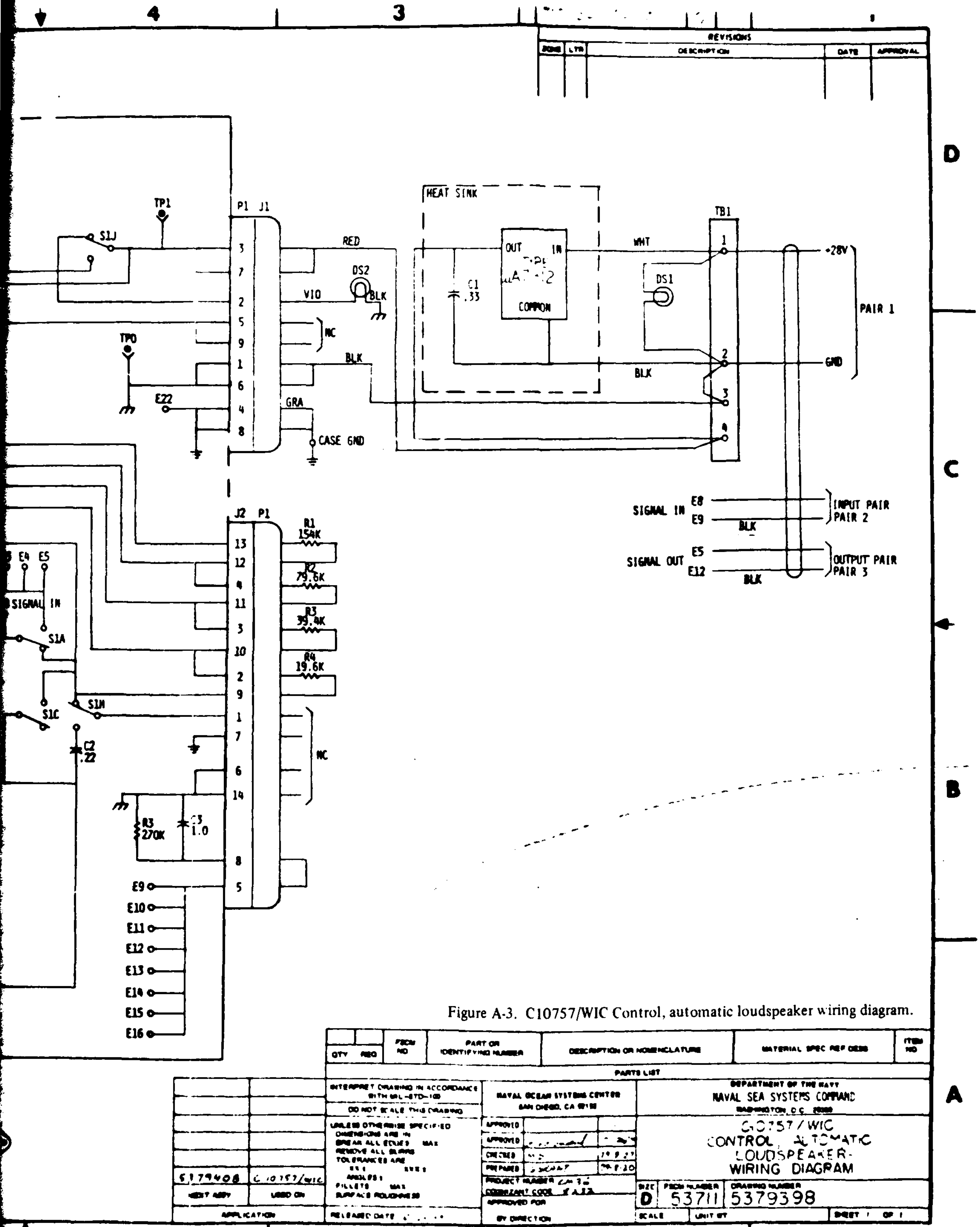


Figure A-3. C10757/WIC Control, automatic loudspeaker wiring diagram.

APPENDIX B
ALC RELIABILITY TEST REPORT

<u>BACKGROUND</u>: The Automatic Loudspeaker Control (ALC) is a device for use with existing announcing systems which will monitor the ambient noise level in a space and adjust the speaker volume in discrete steps to maintain a comfortable signal-to-noise margin. The ALC specified MTBF is 20,000 hours; however, its predicted MTBF is substantially higher (see "Part Stress Reliability Prediction for the Automatic Loudspeaker Control" dated 27 February 1978). Since it is not practical to conduct full MIL-STD-781 reliability demonstrations at these MTBFs, a modified test was conducted to generate engineering confidence in the predictions.

The ALC design effort has proceeded in two phases: brassboard model and engineering model. The engineering model is substantially similar to the brassboard except for the BITE circuitry and a few circuit simplifications. The brassboard model was used in this test because it was available to start the test several months prior to the engineering model. The BITE circuitry is normally turned off; therefore, it does not enter into reliability considerations to any significant degree. The remaining circuitry is sufficiently similar to consider the brassboard and engineering models as being the same for test purposes.

The test was conducted in accordance with the findings of the TELCAM project as documented in the NOSC Project Manager's Guide, NOSC TD-108. Failure-free criteria were applied to combined environment and elevated temperature tests; engineering confidence was furthered by tracking the stability of critical circuit parameters. These parameters were measured at room temperature and at extremely high temperature (+65°C) before and after each test phase. The parameters chosen were the following:

1. Noise proportional voltage for a calibrated input
2. Noise proportional voltage linearity
3. Circuit current consumption with a 12.000V power supply
4. Signal sense circuit switching level
5. Uncompensated power supply output level

Since two power supplies were under consideration, both were submitted to test.

The test was conducted in two phases. The combined environment phase lasted 1000 hours (continuous). The following environments were combined and timed so that each 24 hour test cycle included every combination of environmental extremes:

1.	Temperature:	15°C–65°C
2.	Humidity:	40%–95% (stabilized) with condensation conditions during transitions
3.	Vibration:	0.2g at the lowest resonance frequency
4.	Electrical Input:	low line-high line (±10%) on power supplies; ± regulated limits on circuit card
5.	On-off cycling:	cycled off for 5 minutes at each dwell point

The elevated temperature phase lasted 1500 hours. This was a simple operating soak at +60°C. It is felt that these two phases maximized the stress on circuit components within reasonable limits.

The results can be easily stated -- no failures occurred and no parameter changes occurred beyond the measurement tolerances (±0.5%) of the test instruments. No circuit conditions were noted which would indicate a design weakness. It is concluded that the ALC reliability is component-failure-rate driven, and, therefore, the established predictions are valid within the confidence limits of the MIL-HDBK-217 data.

JOHN H. TOWNSEND
Electronics Engineer
30 June 1978

APPENDIX C
ALC ENVIRONMENTAL TESTING

The following tests were performed on a prototype ALC and an engineering development model ALC at appropriate times during the development. Both were the 70.7 volt line ALCs which includes the heavy transformer and power supply.

<u>ENVIRONMENTAL TEST CONDITIONS</u>

Temperature	MIL-E-16400 Range 4 (0–65°C)
Humidity	MIL-E-16400 (one cycle with front panel open)
Vibration	MIL-STD-167-1 Type I
Shock	MIL-S-901, Grade A, Type A, Class I
Enclosure	Drip proof (45°) IAW MIL-STD-108

Both ALCs came through all the above tests without any measurable degradation.

APPENDIX D
TEST PLAN FOR TECHNICAL EVALUATION OF THE ALC AT NOSC

1. Bench Tests on the ALC

   a. Reaction and release times to signals sensed through the noise sensing circuit and through the signal sensing circuit.

   b. The vibration sensitivity of the noise sensor when mounted as designed.

   c. Noise levels at which ALC switches transformer taps.

   d. Output versus input levels for each transformer tap of ALC.

   e. Transformer operation under full load.

2. Simulated-Noise Operational Tests at NOSC

   a. Set up and data sheet as shown in Figure 1 and 2.

   b. Four noises - pink noise, elevator room noise (intermittent and level varying), diesel noise, and generator noise.

   c. Various noise levels - 65, 85, 95, 105 with slow and fast level changes.

   d. Prerecorded announcement; with 3 different talkers; with short and long messages, with fast and slow speech; all in random order of talker and random spacing between announcements.

   e. Automatic switching of M–124 Mic approximately 2 seconds before and after announcements.

   f. Artificial voice in 65–70 dB ambient.

   g. Graphic level recording of noise as measured by condenser microphone placed near ALC noise sensor - event markers to indicate onset and end of announcements.

   h. Three different loudspeakers tested separately under similar conditions LS–387 (7.5 watts), LS–305 (1 watt), and NT–49546 (10 watts).

   i. Transient noise sources produced by operator inside noise chamber clapboards, hammer dropping and burst of shouting - introduced in random order and intervals.

   j. Continuous recording of sound in noise chamber - two microphones, one in direct line of ALC loudspeaker and one near wall to the side of the ALC loudspeaker - index numbers from this recorder that correspond to changes in test conditions are entered on data sheet.

   k. LED indications of transformer taps selected by ALC are noted visually and are entered on the data sheet.

Test Results

1. Bench Tests on the ALC

   a. – e. All final test measurements within specification. (Problems in design were discovered and then corrected before final test.)

2. Simulated-Noise Operational Tests at NOSC

   All test conditions specified in a. - k. were satisfied. The ALC operated as designed under all test conditions, including not reacting to the loud transient

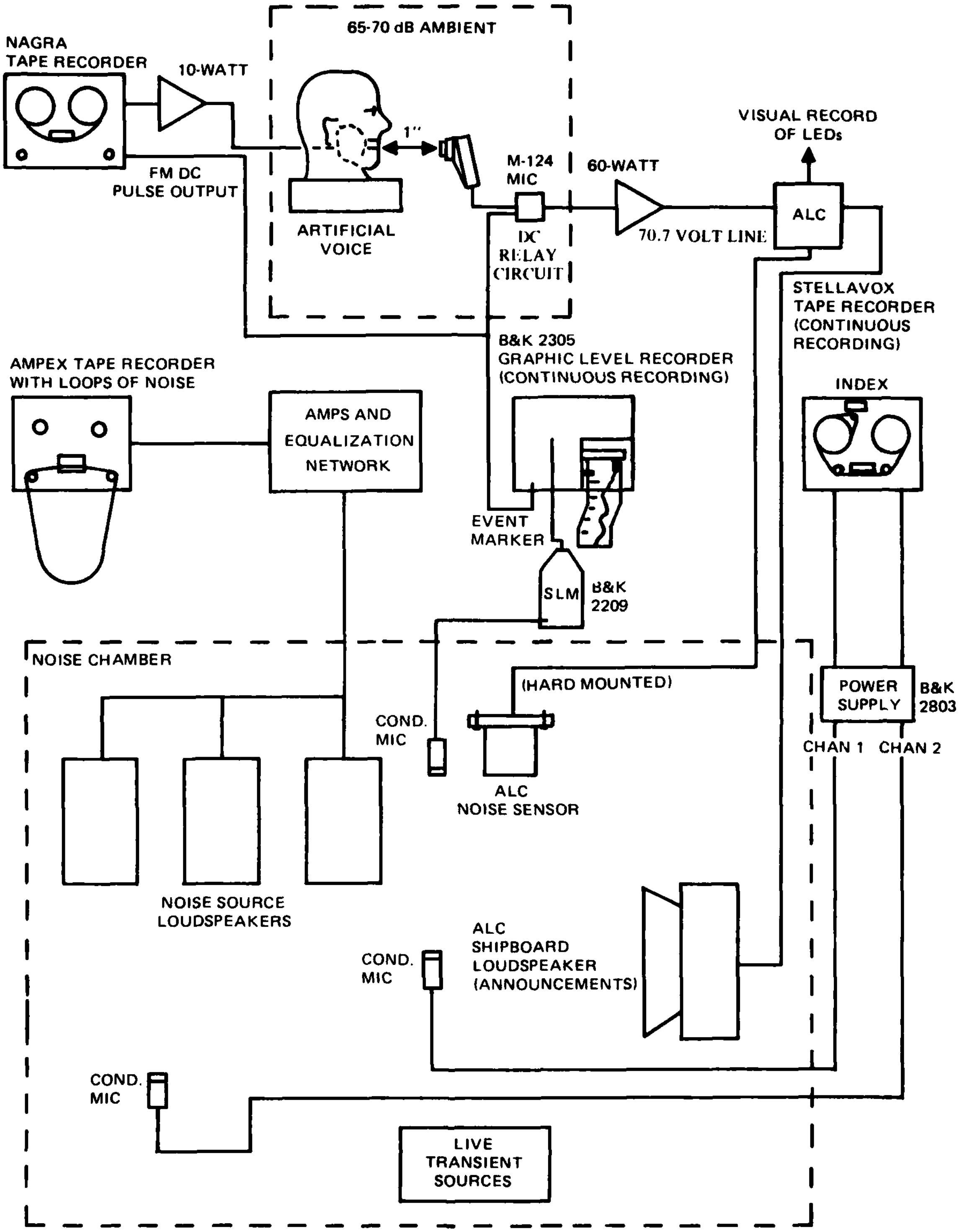


Figure D-1. Simulated-noise operational test of ALC set up at NOSC.

ALC LDSPKER LS-387/SIC

OBSERVERS LM AT CONSOLE

AH IN CHAMBER

*SIGNAL SENSING CIRCUIT SWITCHING ON FOR ANNOUNCEMENT NOSC PROJ. CM 36
**SHIPBOARD ELEVATOR NOISE (SEE KEY AND TABLE D-1) AUG-SEP 1978
***SEE KEY, TABLE D-1.

STEADY NOISE SOURCE	*** KEY	TRANSIENT NOISE SOURCE	NOISE LEVEL STEADY/TRANS	ALC XFORMER TAP	REACTION TO TRANSIENT	RECORDING NO./INDEX READING	ALC NOISE SENSOR INPUT	DATE TIME
(Switch 1) *	(3)		95/00	DS2	0	6/290	0dB	9-15-78/1403
(Switch 2)	(1)		102/00	DS2	0	-		
	(3)	3	105/109	-	-	-		
(Switch 3)	(3)		105/00	DS1	0	308		
	(2)	6	107/113	-	-	-		
	(3)	1	105/113	-	-	-		
(Switch 4)	(5)		96/00	DS2	0	-		
(Switch 5)	(3)	2	106/119	DS1	0	345		
	(1)	6	100/115					
	(3)	3	105/122	-	-	-		
	(2)	4	107/114					
	(4)	2	105/121					
(Switch 6)	(5)	2	97/125	DS2	0	-		
	(5)	6	97/120	-	-	-		
	(5)	3	97/125					
(Switch 7)	(2)		106/00	DS1	0	415		
	(5)	2	97/125	-	-	-		
(Switch 8)	(5)		96/00	DS2	0	-		
(Switch 9)	(3)		105/00	DS1	0	440		
	(5)	7	97/125	-	-	-		
(Switch 10)	(5)		96/00	DS2	0	-		
	(3)	4	105/109					
	(5)	3	97/125	-	-	-		
(Switch 11)	(2)		106/00	DS1	0	471		
	(5)	1	97/120	-	-	-		
(Switch 12)	(3)		105/00	DS1	0	-		
	(5)	1	97/110	-	-	-		
	(5)	4	97/107	-	-	-		
(Switch 13)	(3)		104/00	DS1	0	517		
	(5)	1	97/125					
	(5)	3	97/125	-	-	-		
	(1)	3	100/121					
(Switch 14)	(3)		104/00	DS1	0	-		
	(5)	7	97/125	-	-	-		
(Switch 15)	(5)		96/00	DS2	0	571		9-15-78-1413

Figure D-2. Simulated noise test data sheet.

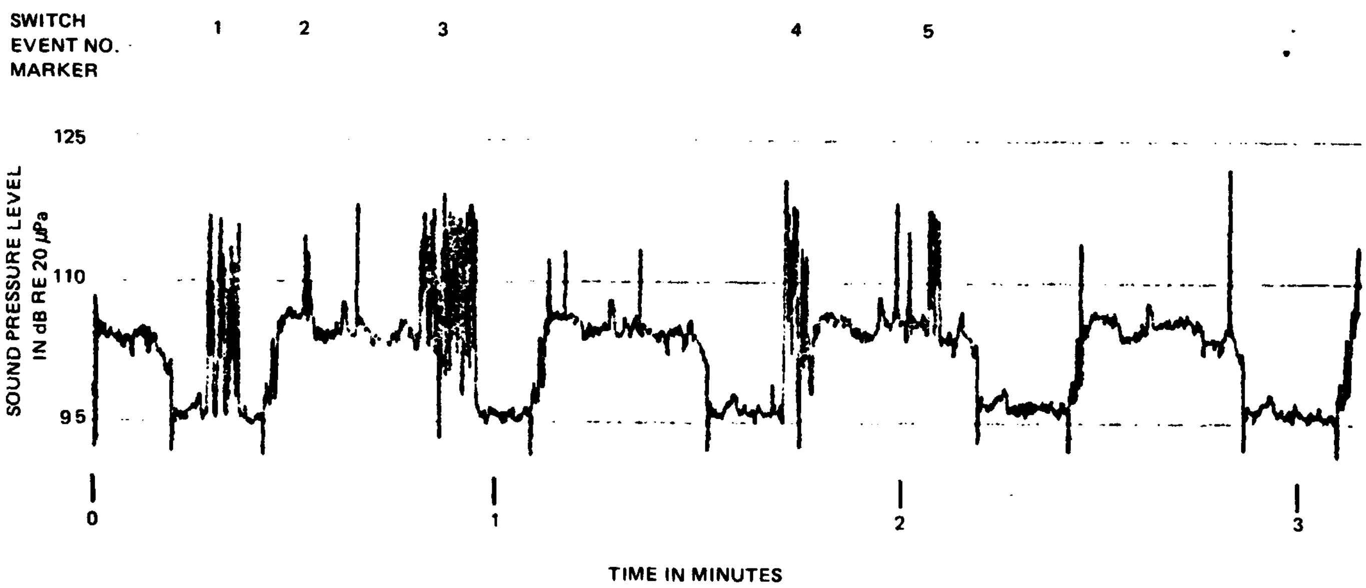


Figure D-3 Graphic Level Recording of Sound Pressure Levels in Simulated Noise Test Chamber During One Complete Test Cycle as Tabulated in Figure D-2.

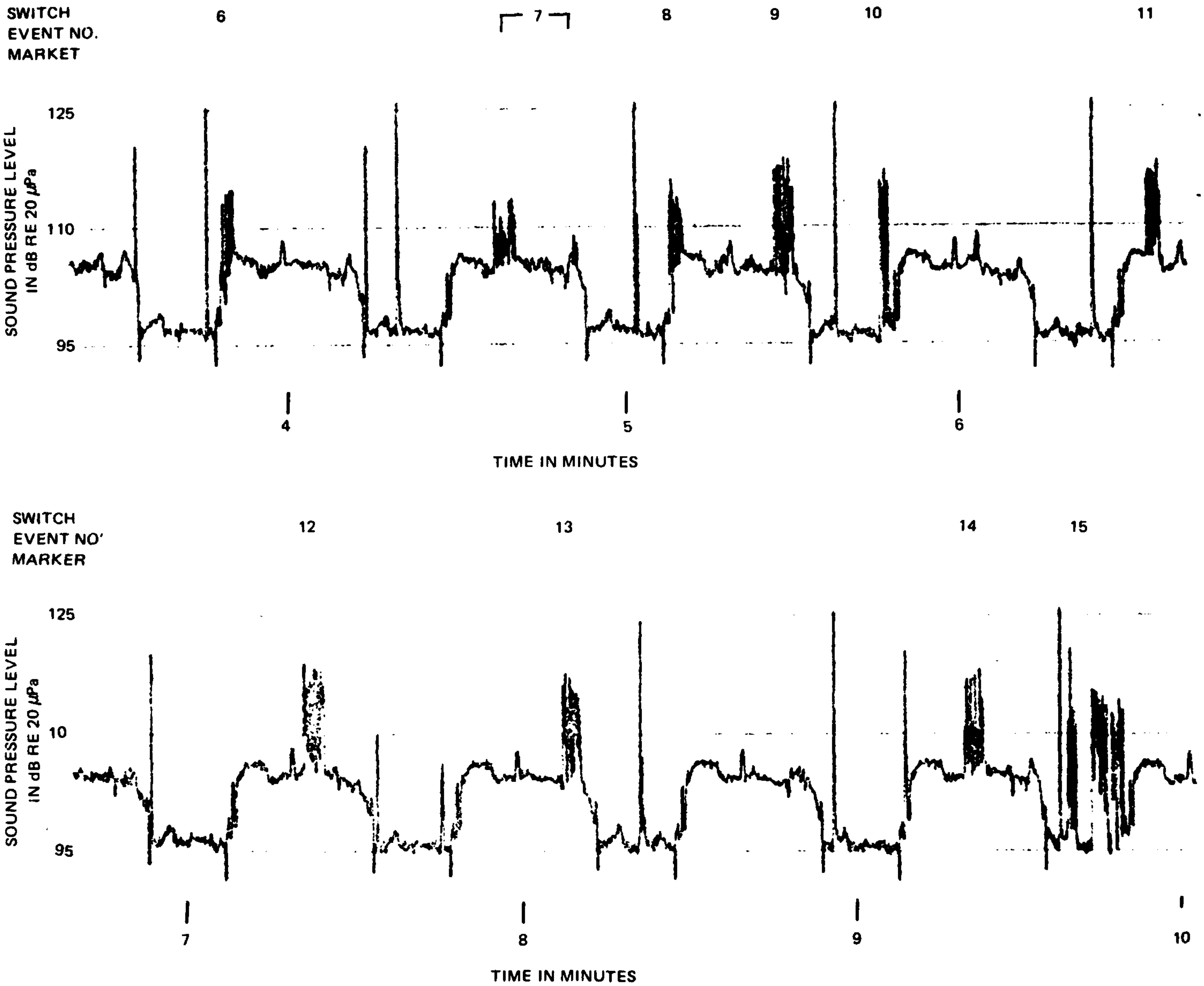


Figure D-3 (Continued) Graphic Level Recording of Sound Pressure Levels in Simulated Noise Test Chamber During One Complete Test Cycle as Tabulated in Figure D-2.

sounds. See sample test data for the LS-387 loudspeaker in a simulated elevator noise field.

Table D-1. Key to Steady and Transient Noise Sources on ALC Data Sheet
STEADY NOISE (SHIPBOARD ELEVATOR) SOURCES

KEY	NOISE LEVELS
(1) Rising elevator noise	97 → 107 dBA
(2) Peak of rising noise	107 dBA
(3) Steady high level right after peak	105 dBA
(4) Falling elevator noise	107 → 97 dBA
(5) Quiet section	97 dBA

TRANSIENT NOISE SOURCES

(1) Dropping hammer on floor
(2) Clapping Clapperboards
(3) Banging metal
(4) Shouting
(5) Dropping hammer on metal
(6) Tapping clapperboards with hammer
(7) Dropping metal plate
(8) Tapping door with hands
(9) Dropping clapperboard on floor
(10) Throwing hammer against bottom of door (banging hammer on floor)

APPENDIX E
TEST PLAN FOR ALC SHIPBOARD OPERATIONAL EVALUATION

1 - 70.7 V line ALC Aboard the USS SCHENECTADY – LST 1185

a. Training IC men using NOSC documentation for installation and maintenance.

b. Installation – Timing rate/rating of IC men, difficulties, safety, accessibility, and adequacy of instructions.

c. Maintenance – Standard checkout with and without fabricated failures Timing, rate/rating of IC men, difficulties, safety, accessibility, and adequacy of instructions and BITE.

d. Shipboard operation – Install 2 ALCs to operate 10 LS-387 loudspeakers in one section of tank deck, listen to announcements during quiet and noisy operations – have ship's officers and tank deck personnel listen also and get their comments. Make recording of these announcements for later analysis, leave ALCs on board for 2 to 3 weeks and then get comments from IC men and tank deck personnel.

2 - 12.2 V line ALC Aboard an SSN

a. Training IC men using NOSC documentation for installation and maintenance.

b. Installation – Timing rate/rating of IC men, difficulties, safety, accessibility, and adequacy of instructions.

c. Maintenance – Standard checkout with and without fabricated failures Timing, rate/rating of IC men, difficulties, safety, accessibility and adequacy of instructions and BITE.

d. Shipboard operation – Install one ALC to operate one 20 watt amplifier-loudspeaker unit in high noise compartment, listen to announcements during quiet and noisy operations – have ship's officers and technicians listen also and get their comments. Make recording of these announcements for later analysis, leave ALCs on board for 2 to 3 weeks and then get comments from ship's personnel.

ALC SHIPBOARD OPERATIONAL EVALUATION TEST RESULTS

70.7 V line ALC – Prototype

a. Approximately 1/2 hour was needed to fully explain ALC installation, maintenance and operation to IC chiefs and IC 1st class. They directed the other IC men in the installation. No problems with this training or instruction.

b. A trial installation uncovered many problems such as dropping screws and having to disassemble the ALC to retrieve the screws. More than two hours were required to install the ALC onto a plywood support and to make all the electrical connections. (The ALC terminals and mounting holes were completely redesigned to eliminate these problems in the EDM models).

c. The maintenance procedure using the BITE was very easy for the IC men to use. However, lack of test points and poor access to the power supply and transformer terminals was cited as a potential problem. (Ten test points and reoriented components eliminated these problems in the EDM models).

d. On 17 Oct 1978 one ALC was installed in the IC room which has a varying noise field due to the proximity to the ship's engines. This ALC is still operating. The IC men report that there have been no problems with this ALC. From time to time they have taught newly assigned IC men to use the BITE, which they all enjoy using; they have not had the opportunity to use this type of BITE.

A second ALC was to be installed in the tank deck or an engine room. This installation, however, required welding a bracket to the bulkhead which the IC men had difficulty scheduling, because this test was not set up through channels.

12.2 V line ALC – EDM MODEL

a. – c. No problems encountered. Mean time to install 10 minutes, Mean-time-to-repair (find simulated problem and replace defective module) – 10 minutes.

d. The ALC was installed and then operated for 3 weeks with only praise for its usefulness and operation.

APPENDIX F
INITIAL PERSONNEL AND TRAINING IMPLICATIONS REQUIREMENTS ANALYSIS FOR THE AUTOMATED LOUDSPEAKER CONTROL (ALC) DEVICE

PREPARED FOR:

Naval Ocean Systems Center (NOSC)
Speech Systems and Interference Branch (Code 8232)

OCTOBER 1978

PREPARED BY:

Naval Sea Support Center, Pacific
Personnel and Training Analysis Department (Code 40)
Post Office Box 80548
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I. INTRODUCTION

A. Purpose

The purpose of this paper is to provide the Naval Ocean Systems Center (NOSC) Speech Systems and Interference Branch (Code 8232) with an initial analysis of the personnel and training implications requirements for the Automated Loudspeaker Control (ALC) device.

B. Approach

Preliminary personnel and training information appearing herein is based upon:

1. Discussions with the ALC Program Manager (NAVSEC 6178C); ALC Project Office (NOSC Code 8232); and Interior Communication Electrician Class "A" School, Service Schools Command, Naval Training Center, San Diego, California instructor personnel.
2. Analysis of available ALC documentation.
3. Review of relevant personnel and training planning publications/ documentation.

C. Application

The ALC (Figures F-1 & F-2) is a device designed to control the level of sound in the existing 1 MC announcing system loudspeaker(s) in a single shipboard space. Present planning calls for the introduction of the ALC into the Fleet starting in FY 1980, with a total programmed procurement of 2500 units. One or more units is planned for each shipboard platform. Installation is expected to be in accordance with a yet to be specified SHIPALT. Projected mean time between failures (MTBF) is 43800 hours with a mean time to repair (MTTR) of 15 minutes. ALC test and evaluation, commenced during the fourth quarter FY 78, is expected to be completed during first quarter FY 79.

D. Limitations

Personnel and training information contained herein is based on the results of an analysis conducted on the ALC engineering development model. It is expected that some modifications to the ALC might occur prior to the award of a production contract for Fleet units. However, these modifications are not expected to have a significant impact on the overall personnel and training implications outlined herein.

II. PERSONNEL AND TRAINING IMPLICATIONS

A. Personnel

Preliminary indications are that no additional personnel will be required to support the ALC on board Navy ships. It appears ALC operation/maintenance tasks will place a minimum workload requirement on existing shipboard technicians. Skills and knowledges required for operation/maintenance of the ALC fall within the qualifications of a Navy Interior Communications Electrician Third Class (IC3) provided he is a graduate of the Basic Electricity and Electronics course (A-100-0010), Interior Communications Electrician Class "A" course (A-623-0012), plus receives training on the ALC. These prerequisite qualifications are considered the minimum necessary to support the ALC on board ship.

CIRCUIT
BOARD
(WITH BITE)

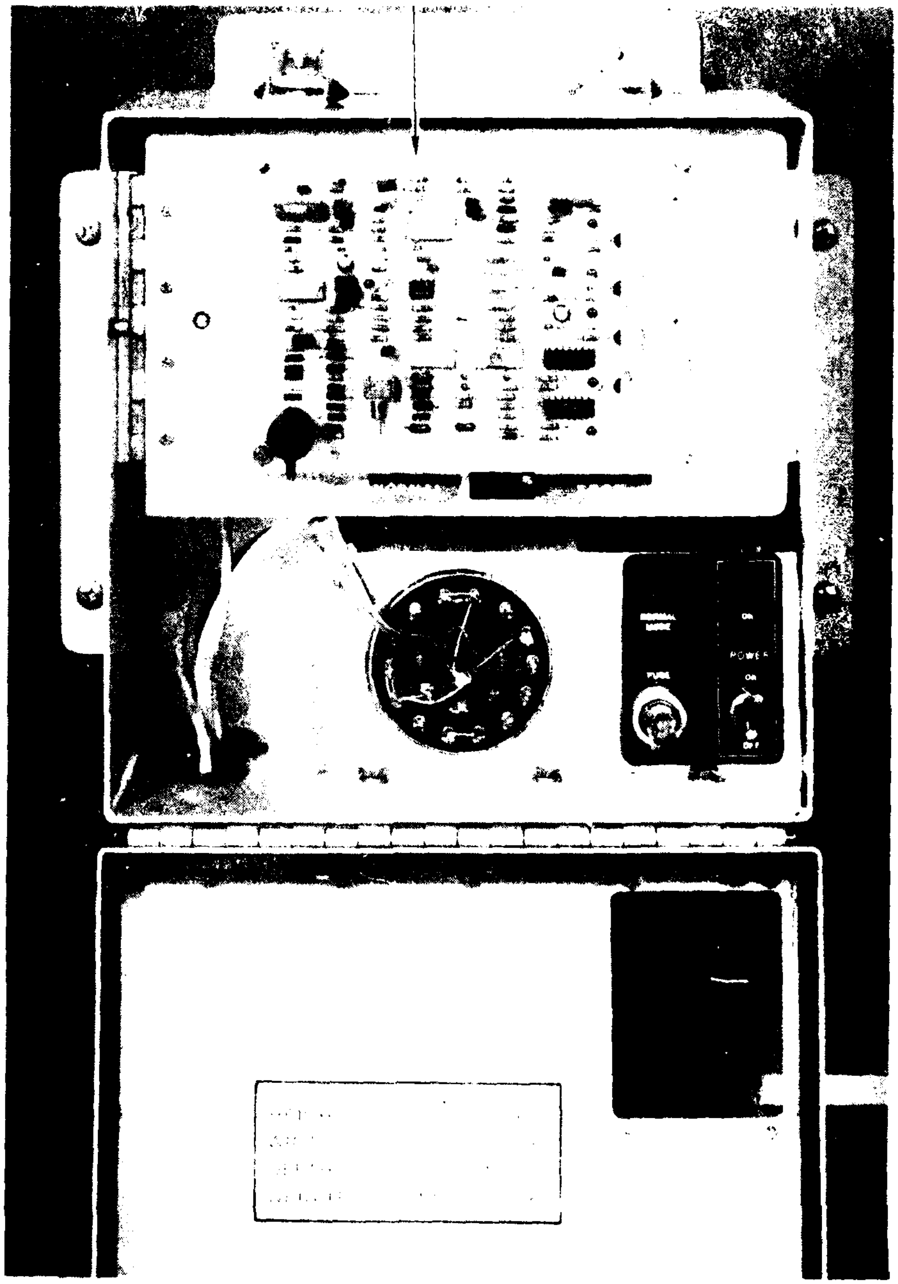

Figure I-1. ALC components and mechanical arrangement (circuit board in place).

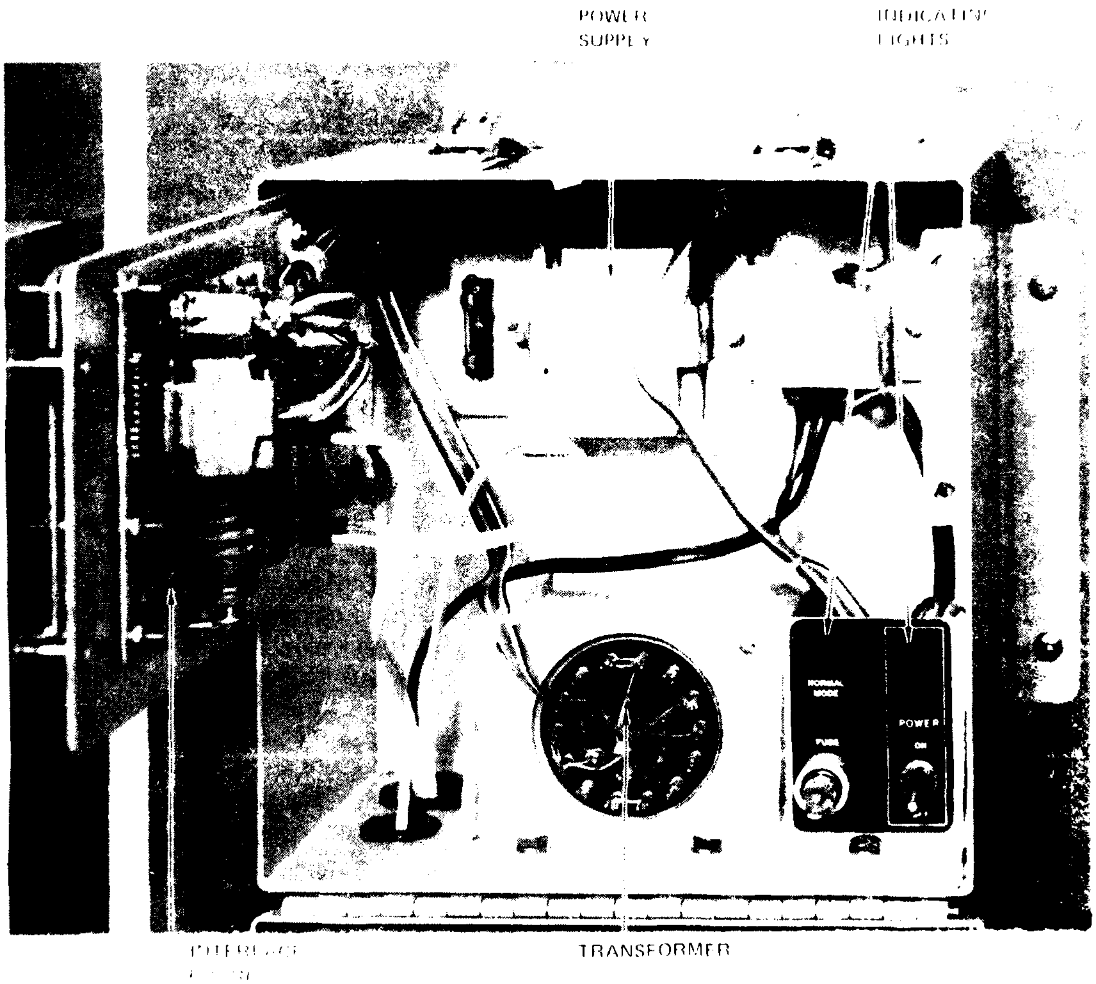

Figure E-[illegible] MLC components and mechanical arrangement (circuit board opened).

The ALC maintenance concept requires some clarification. Review of a NOSC draft technical note on the ALC states that "a faulty circuit board or other subassembly of the ALC can be quickly replaced by a new one and returned to a shop for repair." It is not clear as to what level of maintenance "shop for repair" implies (organizational, intermediate or dept; NAVMATINST 4700.4B refers). If a shipboard IC technician is expected to repair a faulty ALC circuit board, this will impact on the rate level and training prerequisite requirement for maintenance of the ALC. This type of skill (repair of faulty circuit board) is not readily available within the IC3 rate inventory. A higher level of IC (second class or above vice third class) plus completion of additional training (microminiature electronics repair) will be required of the ALC shipboard technician, if he is to be expected to repair circuit boards.

B. Training

At this time, it has not been determined who will install the ALC on board ship: ship's company or civilian technicians (contractor or Tiger Team), or how initial indoctrination on the ALC will be accomplished. This could impact on how well a designated ALC IC technician becomes knowledgeable and skillful in the operation/maintenance of the ALC. To provide an initial cadre of ALC shipboard technicians, it is suggested that qualified civilian technicians provide on-the-job training (OJT) to shipboard IC personnel at the time the ALC is installed. This would insure the availability of a shipboard technician trained in the operation/maintenance of the device: this trained technician could then provide follow-on ALC OJT to other shipboard IC's.

Follow-on formal Navy training does not appear to be warranted to support the ALC. It is suggested, however, that Project Personnel consider the incorporation of a short introduction to the ALC (1–2 hours) into the existing Interior Communications Electrician Class "A" course (A-623-0012), located at the Service Schools Command, Naval Training Center, San Diego, California. With the ALC scheduled to be installed on board all Navy ships, this addition to the IC Class "A" course would not only add to the Navy's IC "A" school trainees' background of new equipments with which they would be familiar, but it would also afford them an opportunity to train on the latest in digitized interior communications equipment during the solid state circuitry portion of the Class "A" IC course. Providing ALC training in Class "A" IC school would eventually provide all IC personnel with knowledge of the ALC, which should enhance the maintainability of the device. To provide this instruction, IC Class "A" school instructor personnel will also require initial ALC training. Such training will need to be provided by either NOSC or contractor personnel at NOSC or contractor's site.

Suggested ALC subject material to be included in the IC Class "A" course should cover such areas as:

1. Introduction and concept of the ALC.
2. Purpose.
3. General description.
4. Applicable safety precautions/procedures.
5. ALC hardware.
6. Operation/maintenance procedures/techniques.
7. Level(s) of maintenance.

8. Troubleshooting and use of ALC built-in test equipment (BITE) and external test equipment requirements.

9. Replacement of faulty modules/components.

10. Maintenance record/report keeping and failure reporting procedures.

In addition, the training site should be provided with a minimum of one ALC, including a noise simulator, and operation/maintenance technical manuals for training purposes. Inclusion of ALC instruction into the Class "A" IC course will require close coordination between the Naval Education and Training Command, training site and ALC project personnel.

III. PERSONNEL AND TRAINING GUIDANCE DIRECTIVES

Timely steps must be taken to ensure that the Navy's manpower, personnel and training systems can absorb the initial impact of a new or modified program/system and produce a continuing pipeline of personnel, trained and qualified to operate and maintain these new or modified programs/systems in the Fleet.

A synopsis of a number of pertinent personnel and training oriented directives is provided as suggested familiarization references. In accordance with existing directives, it is suggested that the ALC Program Manager consult with NAVSEA 047 (Manpower, Personnel and Training Support Division) to determine whether or not an ALC Navy Training Plan is required. Such a plan identifies early personnel and training requirements in relationship to milestones established for the introduction of new or modified programs/systems.

Directive No.	Subject
1. OPNAVINST 1000.16D	Promulgation of Manual of Navy Officer and Enlisted Manpower Policies and Procedures

Provides policies, taskings, procedures and information for acquiring and effectively managing the Navy's manpower resources.

Directive No.	Subject
2. OPNAVINST 1500.2E	Establishment and Coordination of Factory Training Programs for Military and Civilian Personnel; responsibility and procedures for

Provides detailed information on the responsibilities of CNM as a Training Support Agent.

Directive No.	Subject
3. OPNAVINST 1500.8H	Preparation and Implementation of Navy Training Plans in Support of Hardware and Non-Hardware Oriented Developments

Directs Program Managers to comply with specific procedures and provide the resources to ensure the timely planning, programming and implementing actions necessary to provide manpower, personnel and training support for systems, subsystems, subsystem components and non-hardware oriented developments.

Directive No.	Subject
4. NAVMATINST 1500.2C	Preparation and Implementation of Navy Training Plans for New Developments

Assigns actions to SYSCOMS to prepare and implement Navy Training Plans, to ensure the evolvement of optimum training programs properly time-phased with equipment development and production.

5. NAVMATINST 1500.4A — Establishment and Coordination of Factory Training Programs

Delegates CNM responsibilities to SYSCOMS for action to develop requirements for, arrange, and administer factory training programs in support of cognizant programs.

6. NAVMATINST 4000.20A — Integrated Logistic Support Planning Policy

Establishes policies and principles for the life cycle support of systems/equipments.

7. CNM ltr 0421/JDF of 3 Aug 1977 — Acquisition of Data · MIL-STD 1379A (Navy)

Specifies specific Data Item Descriptions (DID's) to be included in Contract Data Requirements Lists (CDRL's) for Navy training contracts according to the category of equipment being developed.

8. MIL-STD 1379A (Navy) — Contract Training Programs

Implements the Navy's requirements for the procurement of contract training programs.

9. NAVSEAINST 1543.1 — Manpower, Personnel and Training Support for NAVSEA Cognizant Ship, System, Equipment, and Non-Hardware Developments

Directs Program Developers to comply with specific procedures for planning and providing manpower, personnel and training support for ships, systems, equipments and non-hardware oriented technical programs sponsored by NAVSEA.

10. NAVSEAINST 7110.1 — Training Support Funding Responsibilities in NAVSEASYSCOM

Sets forth funding responsibility within NAVSEA for personnel and training support for the introduction of NAVSEA cognizant systems, equipments, and processes to the Fleet.

11. CNETINST 1500.9 — Participation by the Naval Education and Training Command in the Preparation and Implementation of Navy Training Plans

Provides guidance and planning policy for training programs to support the introduction of new hardware developments or acquisitions.

12. NAVSUP-1000, Navy Comptroller Manual, Vol. 7, paragraph 075418 — Training and instruction of military personnel

Provides the basis for and assigns the responsibility for funding of training programs.

13. NOSC Technical Document 108 — Project Manager's Guide

Intended as an aid for Project Managers to scope, plan, and set up the required management system for projects requiring R&D within the Navy.

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